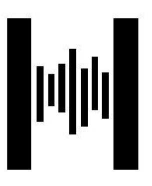
The

HAMMOND

Organ Manual
for the
SERVICE ENGINEER

Models:
A
A-100, AB,
BC, BCV, BV,
B2, B3, C, CV, C2,
C2-G, C3, D, DV, D-100,
E, G, GV, RT, RT2, RT3



This manual is intended for FREE distribution

Foreword to the 2016 Edition

This new edition exists to provide an alternative to the poor quality publications of Hammond's own HOOO-000495 master service manual that surfaced in various guises during the late 70s - early 80s; as well as the even worse quality of the scanned material found on the Internet as of this writing.

Hammond created the HOOO-000495 by making copies of copies, shrinking down diagrams, and resetting certain paragraphs (often sloppily) to accommodate the inclusion of models that were developed after the initial manuals had been written years before.

Every attempt has been made to be as accurate and authentic as possible to the original manuals in terms of content and layout. Pictures have been replaced when possible (or necessary) & sections clarified when needed. The format of this new, inclusive manual follows more closely layout of the older versions from the 50s adding in the newer models in the appropriate places. References to the Model BA were intentionally removed due to lack of documentation of the "player" section. Also removed were any references to buying new parts, as well as the Parts List itself due to their obsolescence.

The diagrams have been scanned at a 600dpi resolution from the oldest sources that could be found. These older sources were typically fold out diagrams 17"x11" in size. While they have been reformatted to 14"x8" to maintain continuity within the PDF format, the high resolution of the scans allows for very clear zooming. Also included are some diagrams and subjects that existed in the 40s & 50s literature, but were omitted from the later 000495 manual.

This endeavor was done for the love of Hammond Organs and to assist in their preservation. It is NOT meant to offer REVISIONS in the diagrams and schematics that differ from Hammond originals. Hammond was very lax in offering revisions and often they were the results of individual technicians based on their experience.

The manual is intended to be distributed FREE of COST.

Thanks goes out to the Audio Playground Synthesizer Museum for scanning the Introduction section and getting the ball rolling.

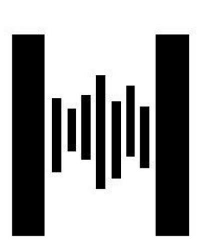
Enjoy...

Joe Luca
May, 2016

THE HAMMOND ORGAN

MANUAL

FOR THE SERVICE ENGINEER

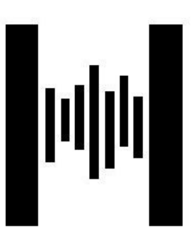


HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

FOREWORD

The Hammond Organ is a product of a company which enjoys a world-wide reputation as a manufacturer of precision electrical devices. The manufacturing facilities devoted to the production of the organ are the finest in existence for this type of work. Thus,a background of specialized engineering experience plus modern fabricating methods are behind the Hammond Organ guarantee.

The Hammond Organ Company, in its guarantee, gives the customer assurance that adequate facilities will be available at all times to service the instrument. This manual is designed to supply the service technician with all information essential to his rendition of this service. It is designed to serve three purposes: first, to help make effective installations; second, as a guide in proper maintenance; and third, to provide instructions on making repairs if they become necessary.



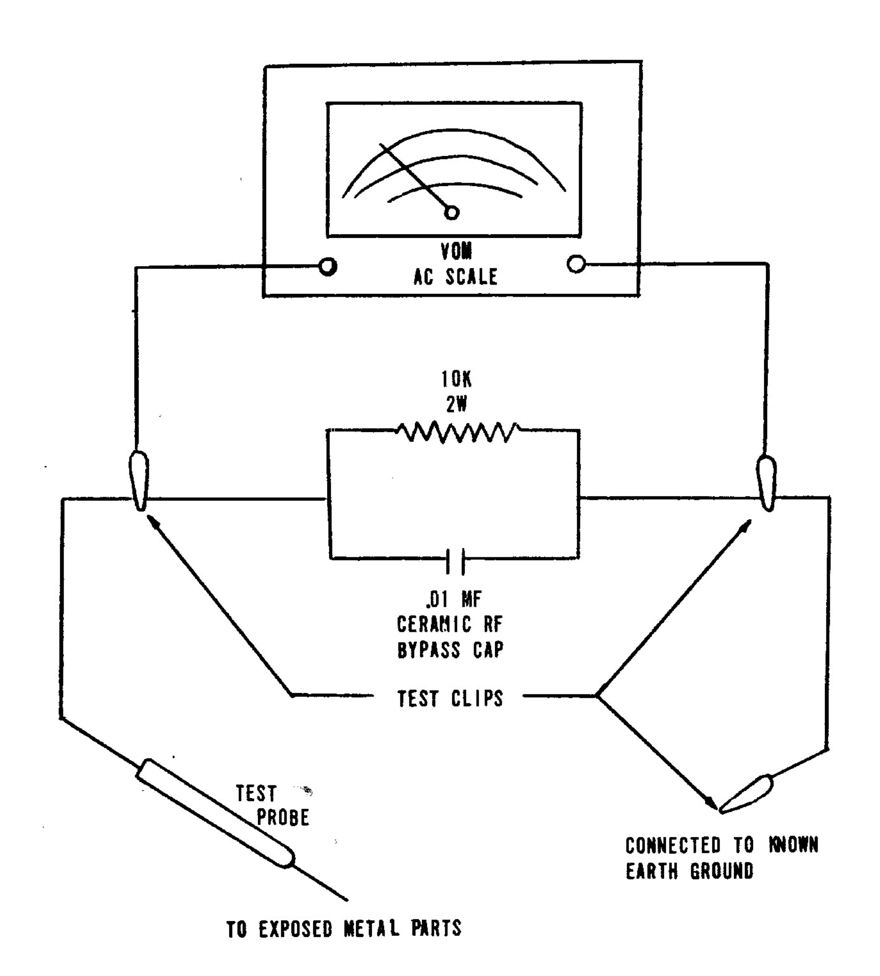
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SAFETY NOTICE

Great care has been taken In the design and manufacture of this product to assure that no shock hazard exists on any exposed metal parts. Internal service operations can expose the technician to hazardous line voltages and accidentally cause these voltages to appear on exposed metal parts during repair or reassembly of product components. To prevent this, work on these products should only be performed by those who are thoroughly familiar with the precautions necessary when working on this type of equipment.

To protect the user, It is required that all enclosure parts and safety Interlocks be restored to their original condition and the following tests be performed before returning the product to the owner after any service operation.

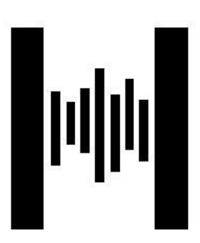
Plug the AC line cord directly Into a line voltage AC receptacle (do not use an Isolation transformer for this test) and turn the product on. Connect the network (as shown below) In series with all exposed metal parts and a known earth ground such as a water pipe or conduit. Use an AC VOM of 5,000 ohms per volt or higher sensitivity to measure the voltage drop across the network. Move the network connection to each exposed metal part (metal chassis, screw heeds, knobs and control shafts, escutcheon, etc.) end measure the voltage drop across the network. Reverse the line plug and repeat the measurements. Any reading of 4 volts RMS or more Is excessive and Indicates a potential shock hazard which must be. corrected before returning the product to the user.



THE HAMMOND ORGAN

– 1 –

INTRODUCTORY SECTION



HAMMOND ORGAN COMPANY
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USA



SPECIFICATIONS MODEL A - AB

IN PRODUCTION: June 1935 to October 1938.
SELLING PRICE: $1,193.00. With Model A-20 Tone Cabinet $1,250.00.
DIMENSIONS: Closed: 48-1/2" wide, 37-5/8" high, 24" deep.
Open: 48-1/2" wide, 47" high, 38-1/2" deep.
FINISH: American walnut.
MANUALS: Swell and Great, 61 playing keys each.
PEDAL KEYBOARD: 25-note, radiating; detachable.
TONAL CONTROLS: 9 preset keys and 2 sets of 9 adjustable harmonic drawbars for each manual; 2 adjustable drawbars (16' and 8') for pedals.
EXPRESSION: One expression pedal controlling Swell, Great, and Pedals.
FEATURES: One tone generator. One adjustable tremulant affecting both manuals and pedals equally.

AC INPUT: Approx. 30 watts, plus wattage required by Tone Cabinets.
WEIGHT: As illustrated, approx. 359 pounds.

Serial No. 2501 and above used larger woodwork case designated as AB. See B series for case dimensions and weight.



SPECIFICATIONS HOME MODELS BC, BV, BCV, B-2, AND B-3

DIMENSIONS: Closed, without pedal keyboard 48-3/8" wide, 28-3/4" deep, 38-3/8" high. Open, with pedal keyboard and bench: 48-3/8" wide, 49-1/2" deep, 46" high.

MODEL AB: Same as Model A but enclosed in larger woodwork. One tone generator, one adjustable tremulant affecting both manuals and pedals equally. Also see Model A for price and production dates.

MODEL BC: Same as Model AB but with one additional generator and appropriate switching to create chorus effect.

IN PRODUCTION. December 1936 to November 1942.

SELLING PRICE: $1,342.00 - Walnut.

MODEL BV: Same as Model B but equipped with Hammond Vibrato providing three degrees of true Vibrato and "off" position, effective simultaneously on both manuals, together with Vibrato Chorus usable in three different degrees and "off".

IN PRODUCTION: April 1946 to December 1949.

SELLING PRICE: $1,881.00 - Walnut.

MODEL BCV:Same as Model BC but has Hammond Vibrato and Vibrato Chorus.
Noneproduced. Converted by Vibrato Kit added after 1945.
Kit price - $275.00.

MODEL B-2:Same as Model BV but with controls which provide Vibrato on either or both manuals. Also additional control for "normal" or "soft" overall volume.

IN PRODUCTION: December 1949 to December 1954.

SELLING PRICE: $2,288.00 - Walnut

MODEL B-3: Same as Model B-2 but with Hammond Percussion feature.

IN PRODUCTION: January 1955 to

SELLING PRICE: $2,745.00 - Walnut. $2,835.00 - Cherry.

MANUALS: Swell and Great, 61 playing keys each.

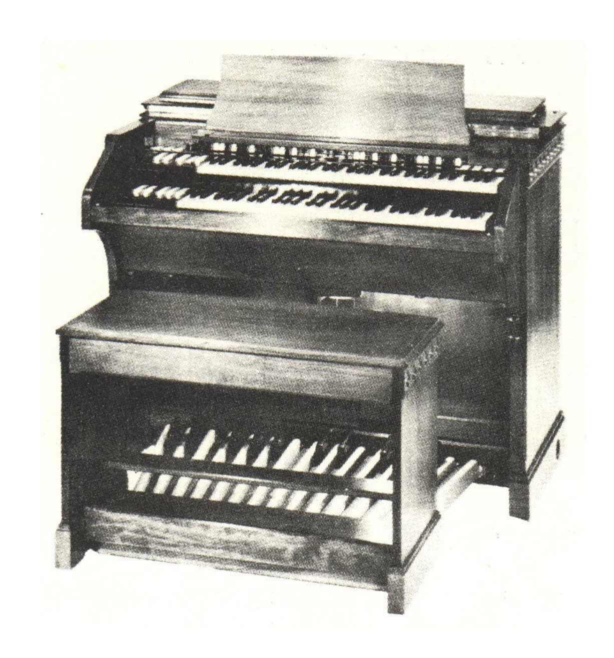
PEDAL KEYBOARD: 25-note radiating, detachable.

TONAL CONTROLS: 9 preset keys and 2 sets of 9 adjustable harmonic drawbars for each manual. 2 adjustable drawbars (16' and 8') for pedals.

EXPRESSION: One expression pedal controlling Swell, Great and Pedals.

AC INPUT: Approximately 30 to 50 watts, plus wattage required by Tone Cabinets.

WEIGHT: As illustrated, approximately 425 lbs.



SPECIFICATIONS CHURCH MODELS C, CV, C-2, C-3, D AND DV

DIMENSIONS: Closed, without pedal keyboard: 48-3/4" wide, 29" deep, 38-3/4" high. Open, and with pedal keyboard and bench: 48-3/4" wide, 47" deep, 46" high.

MODEL C: Same as Model AB but with different style woodwork. One tone generator, one adjustable tremulant affecting both manuals and pedals equally.

IN PRODUCTION: September 1939 to June 1942.

SELLING PRICE: $1,193.00 - Walnut.

MODEL CV: Same as Model C but equipped with Hammond Vibrato, including Vibrato Chorus.

IN PRODUCTION: September 1945 to December 1949.

SELLING PRICE: $1,782.00 - Walnut.

MODEL C-2: Same as Model CV but with controls which provide Vibrato on either or both manuals. Also additional control for "normal" or "soft" overall volume.

IN PRODUCTION: December 1949 to December 1954.

SELLING PRICE: $2,178.00 - Walnut.

MODEL C-3: Same as Model C-2 but with Hammond Percussion feature.

IN PRODUCTION: January 1955 to

SELLING PRICE: $2,545.00 - Walnut. $2,630.00 - Oak.
Later version in both finishes less quatrefoil.

MODEL D: Same as Model C but with one additional tone generator and appropriate switching to create chorus effect. Similar to Model BC.

IN PRODUCTION: June 1939 to November 1942.

SELLING PRICE: $1,342.00 - Walnut.

MODEL DV: Same as Model D but with Hammond Vibrato, including Vibrato Chorus. See BCV.

None produced, Kit added in field.

MANUALS: Swell and Great, 61 playing keys "ch.

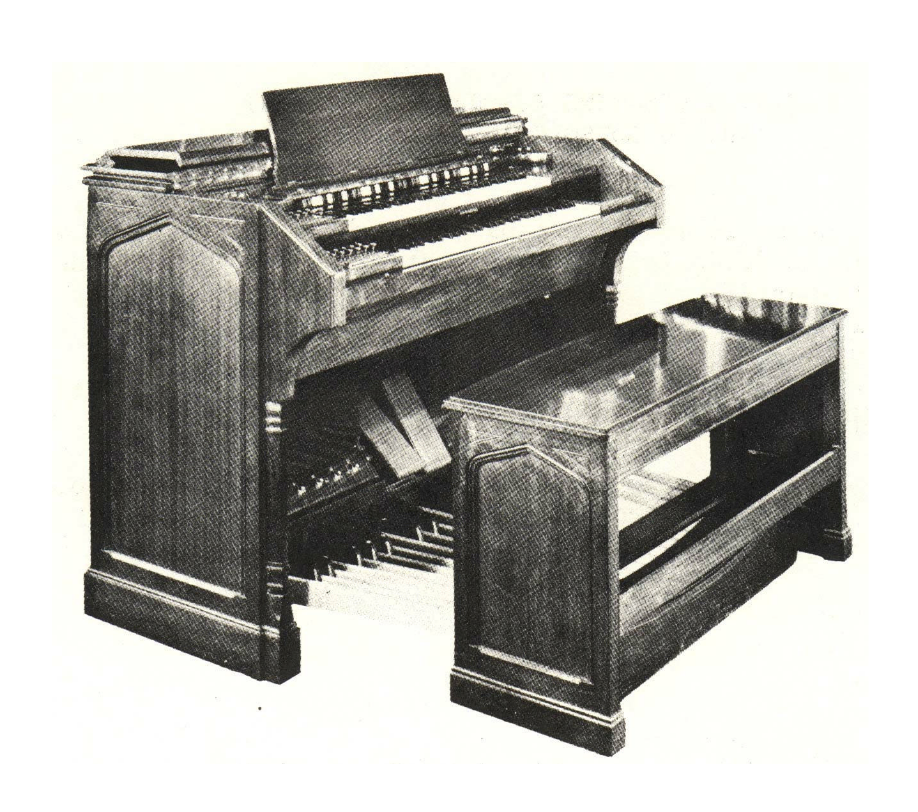
PEDAL KEYBOARD: 25-note, radiating, detachable.

TONAL CONTROLS: 9 preset keys and 2 sets of 9 adjustable harmonic drawbars for each manual; 2 adjustable drawbars (16' and 8') for pedals.

EXPRESSION: One expression pedal controlling Swell, Great, and Pedals.

AC INPUT: Approximately 40 to 60 watts, plus wattage required by Tone Cabinets.

WEIGHT: As illustrated, approximately 450 lbs.



SPECIFICATIONS CONCERT MODEL E

DIMENSIONS: Closed, without pedal keyboard: 57" wide, 40" high, 29" deep.Open, and with pedal keyboard: 57" wide, 46-7/8" high, 47-5/8" deep.

IN PRODUCTION: July 1937 to July 1942.

SELLING PRICE: $1,980.00.

FINISH: American Walnut.

MANUALS: Swell and Great, 61 playing keys each.

PEDAL KEYBOARD: 32-note, concave, radiating, detachable, built to AGO specifications.

TONAL CONTROLS: 9 preset buttons and 2 sets of 9 adjustable harmonic draw-bars for each manual; for pedals - 4 numbered and labeled toe pistons 2 adjustable drawbars (16' and 8') and Great to Pedal 8' coupler.

EXPRESSION: 2 expression pedals, one for Swell and one for Great and Pedals. Visual position indicators of sliding rod type.

FEATURES: Separate adjustable tremulants for Swell and Great Manuals.Standard Main and Chorus generator units; on and off switch for Chorus.

AC INPUT: Approximately 50 watts, plus wattage required by Tone Cabinets.

WEIGHT: As illustrated, approximately 579 lbs.

U.S. GOVERNMENT PURCHASED EQUIPMENT
MODEL G CONSOLE AND TONE CABINET

The Model G consoles and tone cabinets were built for the Government, and now will be found in use throughout the United States and foreign countries in chapels of all services, Officers Clubs, or recreation service buildings.

The console is identical to the Model D except for the decorative woodwork and provision for detachable handles.

The tone cabinet (Model G-40) contains two amplifiers and four speakers mounted in a horizontal row and is electrically similar to Model B-40 tone cabinet, but has a reverberation control unit.

Produced from June 1941 to November 1944.

MODEL C-2G, C-3G CONSOLES AND HR-40G

These consoles are identical in appearance to the C-2 and C-3 except that a monitor speaker is located on the lower left hand side.

The preamplifier in the C-2G is designed to operate the monitor speaker. In the C-3G the preamplifier is the same as in the C-3. A small auxiliary amplifier drives the monitor speaker. In both Models, B+ voltage from the tone cabinet is required to make the monitor speaker operative.

The HR-40G is identical to the HR-40 except that it is equipped with a standard 6 conductor cable which must be used in conjunction with the C-2G console.

C-2G in production June 1952 to March 1953.

C-3G in production January 1955 to ?



SPECIFICATIONS CONCERT MODELS RT, RT-2, AND RT-3

DIMENSIONS: Closed, without pedal keyboard: 57" wide, 40" high, 29" deep. Open, and with pedal keyboard: 57" wide, 46-7/8" high, 47-5/8" deep.

CONCERT MODEL RT: Equipped with Hammond Vibrato providing three degrees of true Vibrato and an "off" position, effective simultaneously on both manuals, together with Vibrato Chorus usable in three different degrees and "off".

IN PRODUCTION: July 1949 to September 1949.

SELLING PRICE: $2,475.00 - Walnut.

CONCERT MODEL RT-2: Same as Model RT but with controls which provide Vibrato on either or both manuals, also additional control for "normal" or "soft" overall volume.

IN PRODUCTION: November 1949 to January 1955.

SELLING PRICE: $2,970.00 - Walnut.

CONCERT MODEL RT-3: Same as Model RT-2 but with Hammond Percussion feature.

IN PRODUCTION: January 1955 to

SELLING PRICE: $3,450.00 - Walnut.$3,555.00 - Oak.

SPECIFICATIONS CONCERT MODELS RT, RT-2, AND RT-3 (Continued)

MANUALS: Swell and Great, 61 playing keys each.

PEDAL KEYBOARD: 32-note, concave, radiating, detachable, built to AGO specifications.

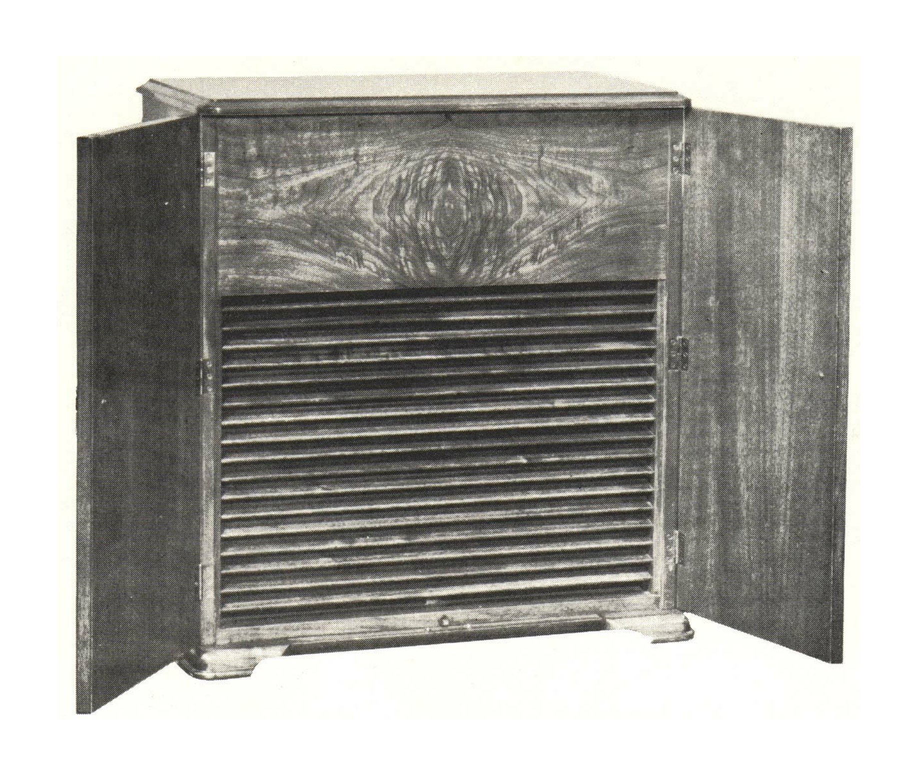
PEDAL SOLO SYSTEM: Has pedal solo system with separate volume control, providing following solo effects; 32-foot Bourdon, 32-foot Bombarde, 16-foot Solo, 8-foot Solo, 4-foot Solo, 2 and 1-foot Solo. Also tablets for Mute Control and Pedal Solo On.

TONAL CONTROLS: 9 preset keys and 2 sets of 9 adjustable harmonic drawbars for each manual; for pedals, two adjustable drawbars (16' and 8').

EXPRESSION: One expression pedal, controlling Swell, Great, and Pedals.

AC INPUT: Approximately 110 to 130 watts, plus wattage required by Tone Cabinets.

WEIGHT: As illustrated, approximately 525 lbs.



MODEL A-20 TONE CABINET

SPECIFICATIONS

IN PRODUCTION: October 1935 to July 1939.

SELLING PRICE: $165.00.

DIMENSIONS: 27" wide, 30" high, 15" deep.

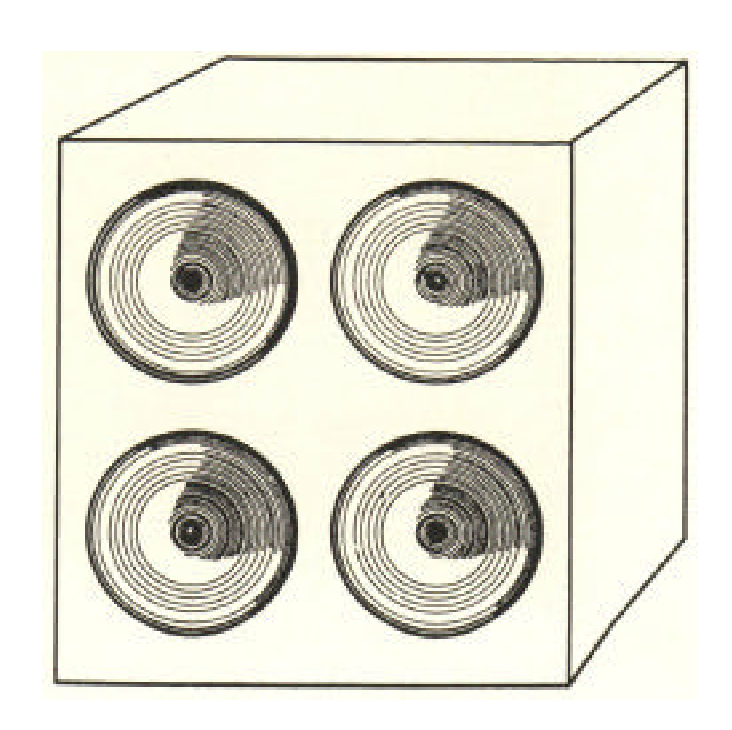
FINISH: American Walnut.

WEIGHT: 113 pounds.

OUTPUT: 20 watts - 1 amplifier, 2 - 12" speakers.

AC INPUT: Approximately 180 watts.

This small decorative tone cabinet is used for homes, mortuaries, and small churches, seating not over 100 persons, where a limited amount of power is required.



MODEL A-40 TONE CABINET
SPECIFICATIONS

IN PRODUCTION: October 1935 to October 1947.

SELLING PRICE: $225.00.

DIMENSIONS: 26-1/2" wide, 28" high, 19" deep.

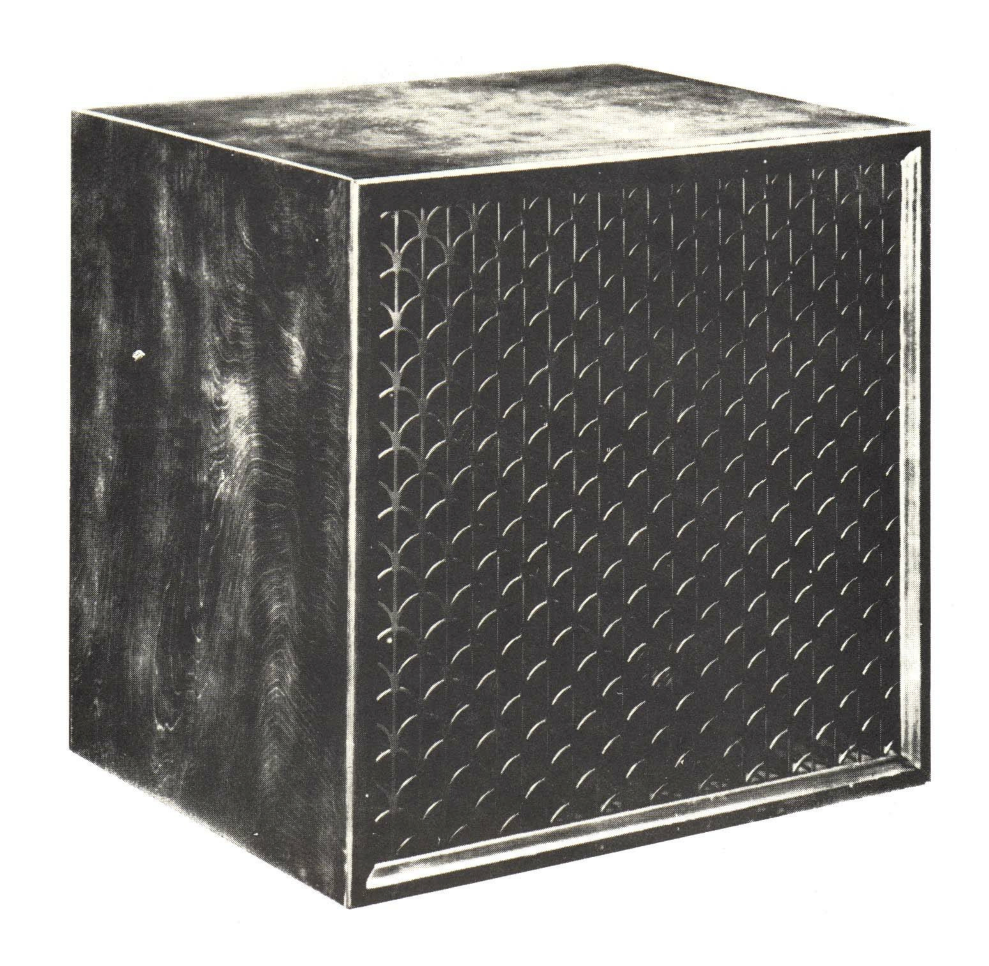
FINISH: Black lacquer.

WEIGHT: 155 pounds.

OUTPUT: 40 watts - 2 amplifiers, 4 - 12" speakers.

AC INPUT: Approximately 360 watts.

A non-decorative, double-strength cabinet, designed for use in banks of four or more, in large installations where the cabinets are concealed.



MODEL B-40 TONE CABINET
SPECIFICATIONS

IN PRODUCTION: November 1936 to December 1947.

SELLING PRICE: $247.00.

DIMENSIONS: 36" wide, 36" high, 28-1/2" deep.

FINISH: Walnut stain.

WEIGHT: 225 pounds.

OUTPUT: 40 watts - 2 amplifiers, 4 - 12" speakers.

AC INPUT: Approximately 360 watts.

A semi-decorative, double-strength cabinet designed for use individual] or in groups. The B-40 is found desirable for many churches and for large installations, for it may be used appropriately in almost any setting.



MODEL C-20, CX-20, AND CXR-20 TONE CABINET
SPECIFICATIONS

MODEL C-20:
IN PRODUCTION: October, 1937 to March, 1942.

SELLING PRICE: $270.00

MODEL CR-20: Equipped with Reverberation Unit.
IN PRODUCTION: 1939 - 1942.

SELLING PRICE: $407.00

MODEL CX-20: Equipped with rotor tremulant. See Page TC-7 for picture of this feature.
IN PRODUCTION: January, 1939 to March, 1942.

SELLING PRICE: $335.00

MODEL CXR-20: Equipped with rotor tremulant and reverberation unit.
IN PRODUCTION: November, 1939 to March, 1942.

SELLING PRICE: $473.00

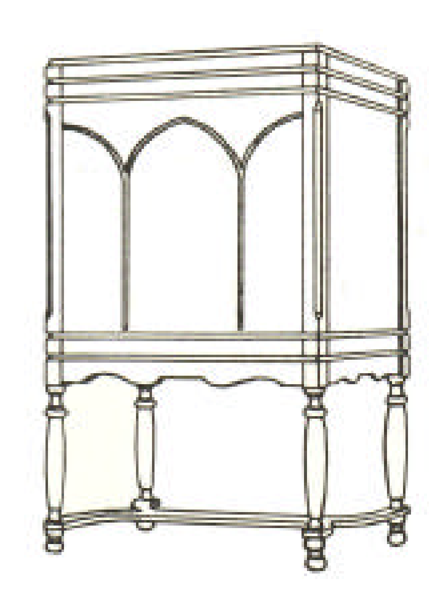
DIMENSIONS: 29" wide, 53" high, 18-1j4" deep.

FINISH: Matched American butt walnut and antique brass hardware.

WEIGHT: 153 lbs.

OUTPUT: 20 watts, 1 amplifier, 2 - 12" speakers.

AC INPUT: Approximately 200 watts.



MODEL C-40 TONE CABINET
SPECIFICATIONS

IN PRODUCTION: June 1936 to December 1937.

SELLING PRICE: $330.00.

DIMENSIONS: 38" wide, 71" high, 27-1/2" deep.

FINISH: Walnut stain.

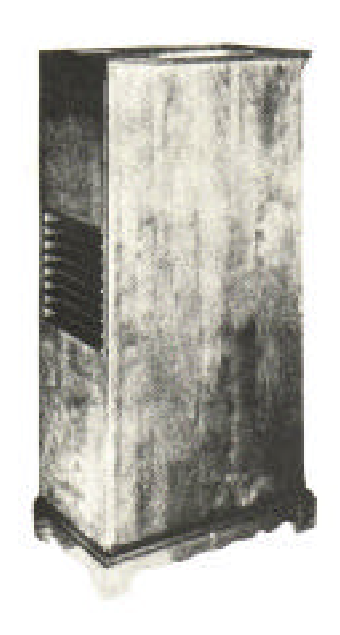
WEIGHT: 313 pounds.

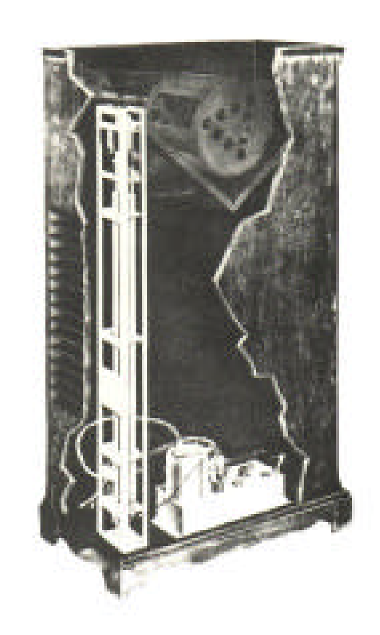
OUTPUT: 40 watts - 2 amplifiers and 4 - 12" speakers.

AC INPUT: Approximately 360 watts.

The C-40 cabinet has a wide variety of applications. It is especially adapted for use in enclosures where the indirect projection of sound is desirable. Very often the ceiling and floor are the only "live" or reflecting surfaces and this type cabinet makes use of these.

The C-40 cabinet is used individually or in groups of two or more.





MODEL. D-20 TONE CABINET   MODEL DXR-20 TONE CABINET

SPECIFICATIONS

MODEL D-20: Tonally identical with Model C-20, the D-20 fills a need for an inexpensive cabinet for use in a wide variety of installations where decorative qualities are a secondary consideration.
IN PRODUCTION: October 1937 to March 1952.

SELLING PRICE: $181.00.

MODEL DX-20: Equipped with rotor tremulant.
IN PRODUCTION: October 1938 to June 1942.

SELLING PRICE: $249.00

MODEL DR-20: Equipped with reverberation unit.
IN PRODUCTION: August 1939 to March 1952.

SELLING PRICE: $319.00.

MODEL DXR-20: Equipped with rotor tremulant and reverberation unit.
IN PRODUCTION: April 1939 to June 1945.

SELLING PRICE: $385.00.

DIMENSIONS: 28" wide, 56" high, 16-3/4" deep.
FINISH: Face and sides of American walnut.
WEIGHT: 149 pounds - D-20; 171 pounds - DR-20; 178 pounds - DXR-20.
OUTPUT: 20 watts - 1 amplifier, 2 - 12"speakers.
AC INPUT: Approximately 200 watts.



MODEL ER-20 TONE CABINET
SPECIFICATIONS

IN PRODUCTION: March 1947 to December 1950.

SELLING PRICE: $462.00.

DIMENSIONS: 31" wide, 38-3/4" high, 18" deep.

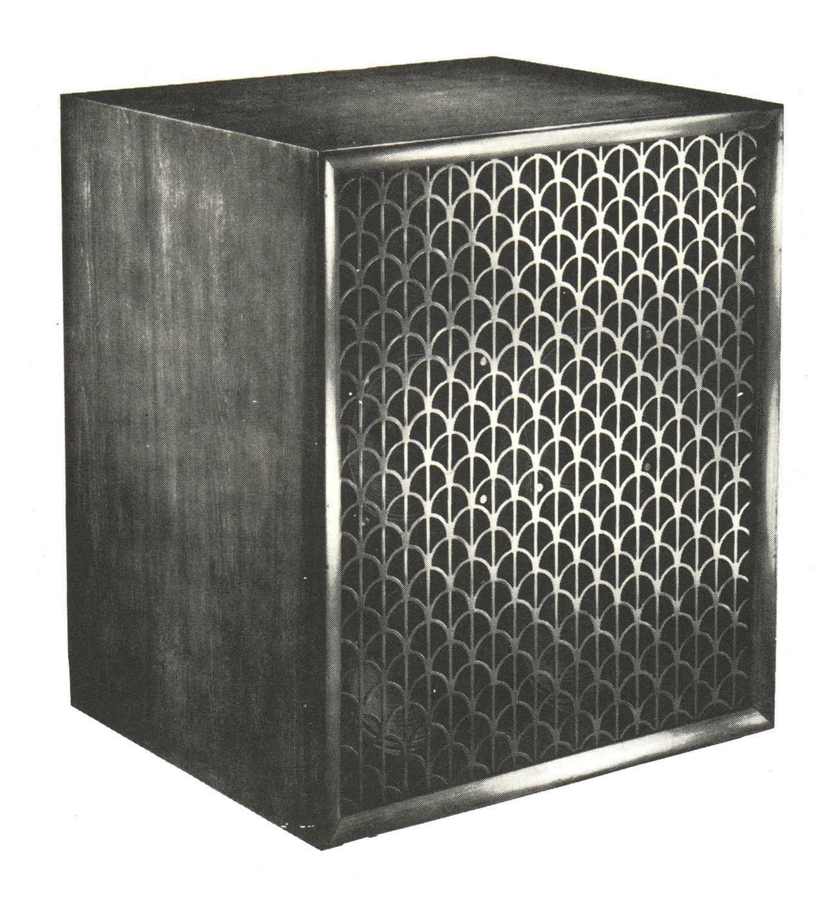
FINISH: Walnut.

WEIGHT: 144 pounds.

OUTPUT: 20 watts - 1 amplifier, 2 - 12" speakers.

AC INPUT: Approximately 200 watts.

The ER-20 tone cabinet is electrically equivalent to the DR-20 tone cabinet. However, the woodwork is designed for use in homes where a more artistic cabinet is preferred.



MODEL F-40 AND FR-40 TONE CABINET

IN PRODUCTION: January 1948 to December 1957.

SELLING PRICE: F-40 - $406.00. FR-40 - $560.00.

DIMENSIONS: 32-15/16" wide; 39-3/16" high; 28-3/8" deep.

FINISH: Walnut stain.

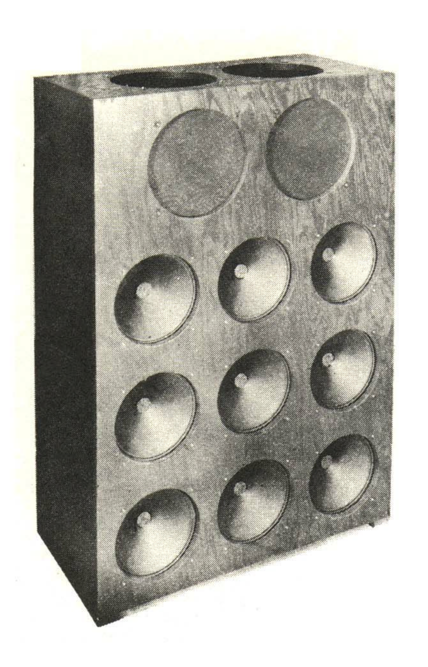
WEIGHT: F-40 - 208 lbs. FR-40 - 228 lbs.

OUTPUT: 40 watts - 2 amplifiers, 4-12" speakers.

AC INPUT: Approximately 300 watts.

The F-40 replaces the B-40 tone cabinet. Dimensions of the woodwork have been altered so that a reverberation unit may be accommodated. With the addition of the reverberation unit it is designated as FR-40.





MODEL H-40, HR-40, K-40, AND KR-40 TONE CABINET

MODEL H-40 AND HR-40:

IN PRODUCTION: October 1948 to February 1960.
SELLING PRICE: H-40 - $517.00 - Walnut.
HR-40 - $585.00 - Walnut.
HR-40 - $605.00 - Oak.
DIMENSIONS: 33-1/8" wide; 48" high; 16-7/8" deep.

MODEL K-40 AND KR-40:

IN PRODUCTION: December 1957 to February 1960.

SELLING PRICE: K-40 - $427.00, KR-40 - $495,00.

DIMENSIONS: 32-l/2" wide; 48" high; 15-7/8" deep,
WEIGHT: K-40 and H-40 - 147 lbs.
KR-40 and HR-40 - 162 lbs.

AC INPUT: H-40 Early Units - 234 watts. Later units - 175 watts.
HR-40 Early Units - 240 watts. Later units - 175 watts.
K-40 and KR-40 - 175 watts.

OUTPUT: 40 watts - 1 amplifier, 11 speakers; 2-12", 9-10".

The H series tone cabinets are designed for use in all types of installations; church, home, school and entertainment places. Their response is non-directional, with the high frequencies projected vertically and the low frequencies horizontally.

The K series tone cabinets are electrically and tonally similar to the H series but are constructed in a utilitarian cabinet. Usually used in concealed installations. The two treble speakers usually mounted on top can be placed on the front baffle for use in chambers where vertical radiation would be restricted.

The tone cabinet contains separate amplifier sections for treble and bass response with cross-over point at 200 cycles.

Amplifiers are not interchangeable with amplifiers in other model tone cabinets.

The HR-40 and KR-40 have reverberation on treble section only. Reverberated signal cannot be fed to another tone cabinet.

Earlier models of the H series tone cabinet were equipped with separate treble and bass amplifier units. These amplifiers were later consolidated in one unit.

For weight of earlier units add 31 pounds to above figures.



MODEL JR-20 TONE CABINET
SPECIFICATIONS

IN PRODUCTION: March 1951 to February 1959,

SELLING PRICE: $452.00 - Walnut. $472.00 - Oak.

DIMENSIONS: 29-3/4" wide; 39-3/4" high; 15-7/8" deep.
WEIGHT: 120 pounds.

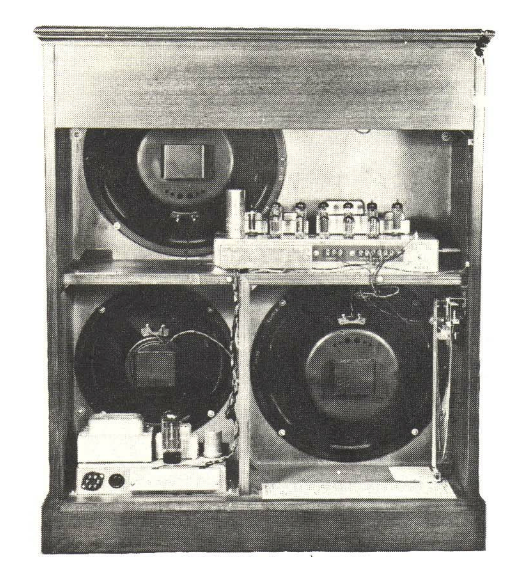
AC INPUT: 100 watts.
OUTPUT: 20 watts - 1 amplifier - 1 treble speaker - 12"
4 bass speakers - 10"

The JR-20 tone cabinet is ideal for the home, small church, mortuary and entertainment places. Its response is non-directional with the highs projected vertically and the lows horizontally.

The amplifier is constructed with separate sections for bass and treble response with a cross-over point at 200 cycles. A reverberation preamplifier is also incorporated in the amplifier chassis and reverberation is obtainable in three degrees on each channel, independent of each other. The reverberation signal cannot be transferred to other tone cabinets.



MODEL PR-20 FRONT



MODEL PR-20 REAR

SPECIFICATIONS

IN PRODUCTION: February 1959 to July 1963.

SELLING PRICE: Walnut - $485.00
Oak - $505.00
Provincial - $505.00

DIMENSIONS: 31-1/2" wide; 37-1/2" high; 18" deep.

WEIGHT: 118 lbs.

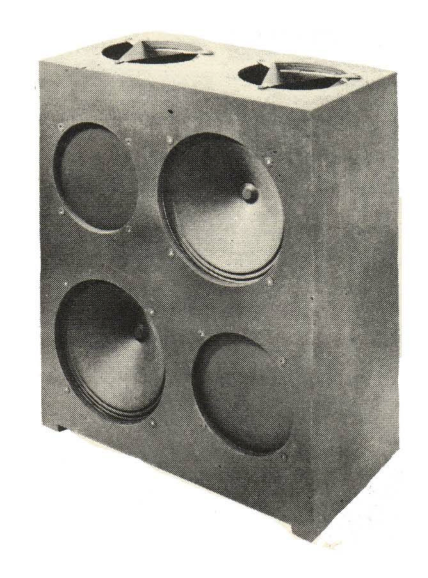
AC INPUT: 185 watts.

OUTPUT: 20 watts.

Equipped with two 15" speakers for bass tones and two 12" speakers for the treble tones. They provide three dimension amplification which creates a beautiful reverberation effect in stereo. These cabinets feature the new and improved Hammond Reverberation control for both bass and treble tones. Convenient outside controls make it easy to change the degree of reverberation for each.



MODEL P-40



MODEL Q-40

MODEL P-40:
IN PRODUCTION: June 1959 to April 1963.
SELLING PRICE: $540.00 - Walnut. $560.00 - Oak. $560.00 - Provincial.
DIMENSIONS: 31-1/2" wide; 37-1/2" high; 18" deep.
WEIGHT: 126 lbs.

MODEL Q-40:
IN PRODUCTION: June 1959
SELLING PRICE: $465.00
DIMENSIONS: 31" wide; 36-5/8" high; 17-1/4" deep.
WEIGHT: 110 lbs.
AC INPUT: 175 watts.
OUTPUT: 55 watts E.I.A.

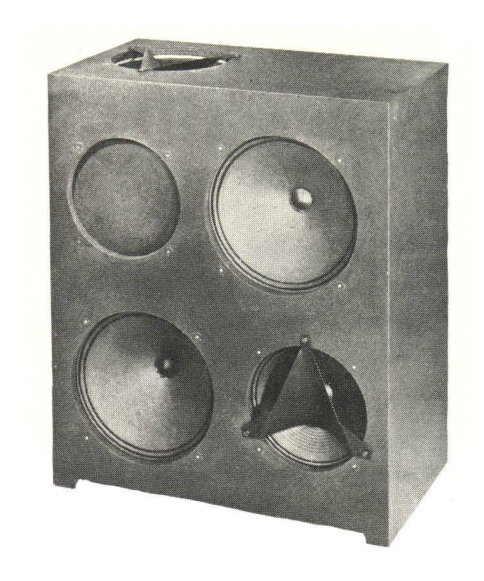
Equipped with a two channel amplifier, two 15" speakers and two 12" speakers serving the bass and treble channels respectively. This tone cabinet in conjunction with a Hammond tone cabinet with reverberation can add the additional power required for larger installation at a minimum cost. Can also be used alone where sufficient natural reverberation is evident.

The Q-40 is electrically similar to the P-40 but with utility type cabinet is only used where appearance is not a consideration such as tone and reverberation chambers.

The treble speakers are normally mounted in the top. In unusual installation where the ceiling is very low, or cabinets are stacked or radiation is otherwise restricted, it is possible to move these speakers to the holes provided in the front. The metal diffusers in front of the speakers must also be moved and the wooden covers must be attached under the top to close the holes.



MODEL PR-40



MODEL QR-40

SPECIFICATIONS

MODEL PR-40:

IN PRODUCTION: February 1959
SELLING PRICE: $615.00 - Walnut
$645.00 - Oak
$645.00 - Cherry
DIMENSIONS: 31-1/2" wide; 37-1/2" high; 18" deep.
WEIGHT: 130 lbs.

MODEL QR-40:

IN PRODUCTION: June 1959.
SELLING PRICE: $535.00
DIMENSIONS: 31" wide; 36-5/8" high; 17-1/4" deep.
WEIGHT: 121 lbs.
AC INPUT: 220 watts
OUTPUT: 50 watts E.I.A.

Equipped with two 15" speakers for bass tones and two 12" speakers for the treble tones. They provide three dimension amplification which creates a beautiful reverberation effect in stereo. These cabinets feature the new and improved Hammond Reverberation control for both bass and treble tones. Convenient outside controls make it easy to change the degree of reverberation for each.

MODEL PR-40 AND QR-40 SPECIFICATIONS (Continued)

The QR-40 is electrically similar to the PR-40 but with its utility type cabinet is only used where appearance is not a consideration, such as in tone and reverberation chambers.

The treble direct speaker is normally mounted in the top. In an unusual installation where the ceiling is very low, or cabinets are stacked or radiation is otherwise restricted, it is possible to move this speaker to the hole provided in the front. The metal diffuser in front of the speaker must also be moved, and the wooden cover must be attached under the top to close the hole.



SPECIFICATIONS A-100 SERIES

MODEL	STYLE	FINISH	IN PRODUCTION	SELLING PRICE
A-100	Traditional	Lt. Walnut	Sept.'59 to Oct.'65	$2,595.00
A-100	Traditional	Red Mahogany	Oct. '60 to Oct.'65	2,545.00
A-101	Contemporary	Br. Mahogany	Jan. '61 to Oct.'65	2,695.00
A-101	Contemporary	Gr. Mahogany	Jan. '61 to Oct.'65	2,770.00
A-101	Contemporary	Tr. Black	Jan.'61 to Nov.'64	2,695.00
A-102	Fr.Provincial	Lt. Cherry	Jan. '61 to Oct.'65	2,770.00
A-102	Fr.Provincial	Dk. Cherry	Jan. '61 to Oct.'65	2,770.00
A-105	Tudor	Walnut	June '62 to Oct.'65	2,995.00
A-105	Tudor	Oak	Feb.'63 to Oct.'65	3,025.00
A-122	Contemporary	Patina Walnut	July'64 to Oct.'65	2;695.00
A-143	Early American	Med.Cherry	Aug.'64 to Oct.'65	2,770.00

MANUALS: Swell and Great, 61 playing keys each.

PEDAL KEYBOARD: 25-note radiating, detachable.

TONAL CONTROLS: 9 preset keys and 2 sets of 9 adjustable harmonic drawbars for each manual. 2 adjustable drawbars (16' and 8') for pedals.

EXPRESSION: One expression pedal controlling Swell, Great and Pedals.

PERCUSSION: Four tablets for control of Hammond percussion feature.

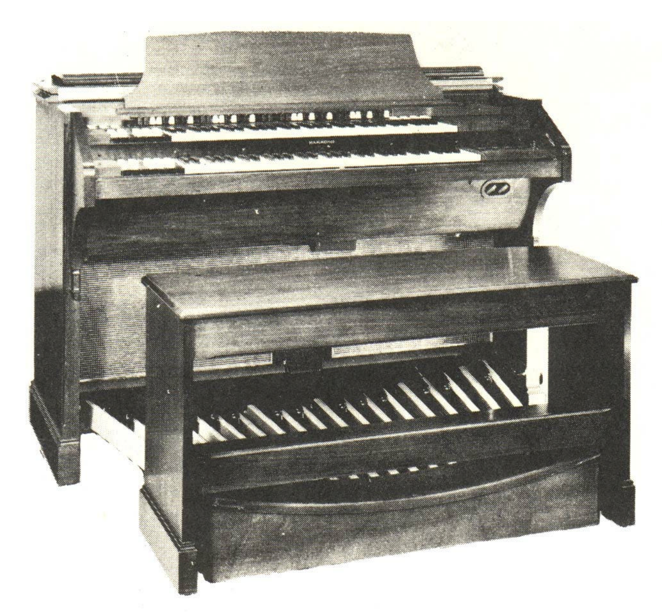
REVERBERATION: One knob control for "off" and all intensities.

DIMENSIONS: With bench and music rack: 47" wide; 45-1/2" high; 43" deep.

AC INPUT: 200 watts.

OUTPUT: 27 watts E.I.A

WEIGHT: Complete 381 lbs.



SPECIFICATIONS D-100 SERIES

MODEL STYLE FINISH	IN PRODUCTION	SELLING PRICE
D-152 Tudor Walnut	July '63 to Sept. '69	$3,725.00
D-155 Tudor Oak	July '63 to Sept. '69	3,830.00

MANUALS: Swell and Great, 61 playing keys each.

PEDAL KEYBOARD: 32-note, concave, radiating, detachable, built to A.G.O. specifications.

PEDAL SOLO SYSTEM: Has pedal solo system with separate volume control, providing following solo effects; 32-foot Bourdon, 32-foot Bombarde, 16-foot Solo, 8-foot Solo, 4-foot Solo, 2 and 1-foot Solo.Also tablets for Mute Control and Pedal Solo On

TONAL CONTROLS: 9 preset keys and 2 sets of 9 adjustable harmonic drawbars for each manual; for pedals, two adjustable drawbars (16' and 8').

EXPRESSION: One expression pedal, controlling Swell, Great, and Pedals.

TILT TABLETS: Three providing control of vibrato. Four controlling Hammond percussion feature.

REVERBERATION: Two knobs for "off" and all intensities in bass and treble channels.

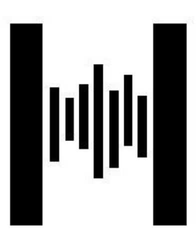
DIMENSIONS: Open as shown, 57" wide; 47" high; 48" deep.

AC INPUT: 330 watts.
OUTPUT: 50 watts E.I.A.
WEIGHT: 543 lbs.

THE HAMMOND ORGAN

–2–

GENERAL DESCRIPTION
&
OPERATING INSTRUCTIONS



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

THEORY OF OPERATION

The console of the Hammond Organ contains the entire tone-producing mechanism, which is completely electrical in operation. Within it are produced all the tones and tone combinations of the organ. The electrical waves are made audible, as music, by one or more tone cabinets containing suitable amplifiers and loud speakers. The block diagrams (Figures 13 and 14) show the chief components of the instrument.

Electrical impulses of various frequencies are produced within a unit known as the tone generator, containing a number of phonic wheels or tone wheels driven at predetermined speeds by a motor and gear arrangement. Each phonic wheel is similar to a gear, with high and low spots, or teeth, on its edge. As the wheel rotates these teeth pass near a permanent magnet, and the resulting variations in the magnetic field induce a voltage in a coil wound on the magnet. This small voltage, when suitably filtered, produces one note of the musical scale, its pitch or frequency depending on the number of teeth passing the magnet each second.

A note of the organ, played on either manual or the pedal keyboard, generally consists of a fundamental pitch and a number of harmonics, or multiples of the fundamental frequency. The fundamental and eight harmonics available on each playing key are individually controllable by means of drawbars and preset keys or buttons. By suitable adjustment of these controls the player is enabled to vary the tone colors at will.

The resulting signal passes through the expression or volume control and through the preamplifier (where vibrato is introduced) to the tone cabinet. Here reverberation is added electrically and a power amplifier feeds the signal into loud speakers.

DESCRIPTION

A Hammond Organ console (Fig. 2) includes two manuals or keyboards: the lower, or Great, and the upper, or Swell, and a pedal keyboard of 25 keys. The concert models have a 32-key pedalclavier and are constructed to A. G. O. specifications. Various controls have appeared on different models. The operation of these controls is covered in the following paragraphs.

STARTING THE ORGAN



FIGURE 1

To start the organ, hold the start switch (Fig. 1) in on position for approximately eight seconds. Still holding it, push the run switch to on position. After leaving both switches on for about four seconds, release the start switch to return to its normal position.

If the console is very cold, or if a frequency regulator is used, it may be necessary to hold the start switch slightly longer.

The Concert Model
Hammond Organ





The Home Model
Hammond Organ

The Self Contained Model
Hammond Organ



PRESET KEYS

At the left end of each manual are twelve keys identical to the playing keys except reversed in color (Fig. 3). These are replaced by twelve numbered buttons on the Model E console.



FIGURE 3

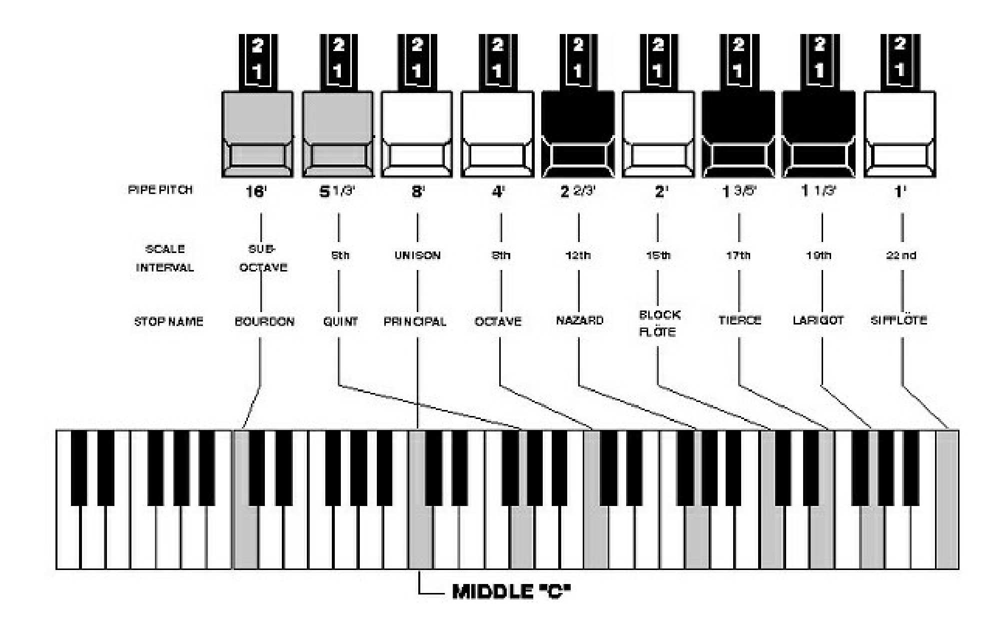
When a preset key is depressed it locks down and is released only when another is depressed. The exception to this is the cancel key at the extreme left, which serves only to release any key which may be locked down. Only one preset key is used at one time. If by mistake two are depressed and locked, they may be released by means of the cancel key.

Each preset key, with the exception of the cancel key and the two adjust keys at the extreme right of the group, makes available a different tone color which has been set up on the preset panel located inside the console. These tone colors are set up at the factory in accordance with a standard design which has been found to best meet the average organist's requirements. They may be changed, if desired, by removing the back of the console and changing the preset panel connections in accordance with instructions on a card located near the preset panel.

When either adjust key is depressed, the organ speaks with whatever tone color is set up on the harmonic drawbars associated with that key. The percussion effect on Models B-3, C-3, RT-3, A-100 & D-100 is introduced when the upper manual B preset key is depressed (see Percussion also).

HARMONIC DRAWBARS

Each console has four sets of harmonic drawbars, two for each manual. Figure 4 shows one group of harmonic drawbars, by which the organist is enabled



to mix the fundamental and any, or all, of eight different harmonics in various proportions. The third bar from the left controls the fundamental, and each of the other bars is associated with a separate harmonic. If a drawbar is set all the way in, the harmonic it represents is not present in the mixture.

Each drawbar may be set in eight different positions by the organist in addition to the silent position. Each position, as marked on the drawbars, represents a different degree of intensity of the harmonic it controls. When drawn out to position 1, the harmonic it represents will be present with minimum intensity, when drawn out to position 2, with greater intensity, and so on up to position 8.

A tone color is logged by noting the numerical position of the various drawbars. For instance ,the tone set up on Figure 4 is known as tone 34 630 5210. After a tone is so logged it may be made available again by setting the harmonic drawbars to that number.

The drawbars in earlier consoles have distinct intensity positions with silent spots between them. Later consoles are equipped with continuous contact drawbar s which move smoothly with no interruption in tone.

HARMONIC DRAWBARS FOR THE PEDALS

In the pedals the harmonic resources have been combined into two drawbars which may be used separately or in combinations. When the left drawbar is used emphasis is given to the lower harmonics, and similarly the higher harmonics are emphasized when the right drawbar is used. The pedal drawbars are located between the two sets of manual drawbars.

PEDAL TOE PISTONS - CONCERT MODEL E CONSOLE



FIGURE 5

Four pedal toe pistons are located to the left of the expression pedals. Numbers one and two of these pistons are pedal presets. The third is a Great-to-Pedal coupler, which makes the pedals speak with whatever 8 foot tone is set up on the Great manual. The left pedal drawbar may be used with the coupler to add 16 foot tone. The fourth piston connects the pedals to the two pedal drawbars.

Lighted piston indicators are provided on the left side of the console just above the Swell manual. Each time a toe piston is depressed, the proper indicator is automatically illuminated so the organist always knows which toe piston is depressed.

PEDAL SOLO UNIT - MODELS RT, RT-2, RT-3, and D-100

A pedal solo unit is incorporated in the Concert Models with prefix RT and D to provides a series of bright pedal solo tones in addition to the usual pedal accompaniment tones available on other models. The pedal solo tones, generated by a vacuum tube oscillator circuit, are controlled by a volume control knob and eight tilting stop tablets located at the right end of the Great manual (Fig. 5). One tablet turns all the pedal solo tones on or off and the others provide various pitch registers and tone colors. The pedal solo unit is independent of the electromagnetic tone generator and can be turned off without affecting the remainder of the organ.

NORMAL - SOFT VOLUME CONTROL
(Models B-2, B-3, C-2(G), C-3, RT-2, RT-3, A-100, D-100)

This control (upper left, Fig. 3) is a tilting tablet which supplements the action of the expression pedal. In soft position it reduces the volume of the whole instrument. It is particularly useful when playing in a small room or when the organist wishes to practice without disturbing others.

CHORUS CONTROL
(Models BC, BCV, D, DV, E, G)

On these models an extra generator known as a chorus generator will be found. To use the tones generated by this unit at will, one extra black drawbar has been added which operates a switch located on the generator. The drawbar labeled chorus is located at the right-hand end of the console. (Fig. 6)

When the organ is played with the chorus drawbar pushed in (the off position) it operates in exactly the same way as though no chorus were included. Pulling the drawbar out (to the on position) instantaneously adds the ensemble or chorus effect to whatever is being played. Actually it adds a series of slightly sharp and slightly flat tones to the true tones produced by the main generator. The resulting electrical wave contains a complex series of undulations which enhance the pleasing effect of many tone qualities, notably string and full organ combinations.

The chorus control should not be confused with the vibrato chorus effect, described under vibrato.. The two effects are similar musically, but are produced by completely different means.

EXPRESSION OR SWELL PEDAL

The swell pedal, located in the customary position, is operated by the right foot and with it the volume of the organ may be controlled over a wide range. It operates on the two manuals and pedals equally; that is to say, once the manuals and pedals are balanced, they retain their relative balance over the entire swell pedal range.

Two expression pedals are provided for the Model E Console. Both are equipped with adjustable clamps to regulate the tension and the distance through which they move. Adjustable pedal indicators, operated by wires from the rheostat box, are located at the extreme right side of the console above the Swell manual.

ECHO SWITCH

Located above the starting and running switches on some consoles is the echo switch (Fig. 6). With this switch it is possible to use two tone cabinets and have either cabinet or both speak, depending on the position of the switch. Generally one tone cabinet is placed rather distant from the console and is called the echo organ. This feature can be added to a Hammond Organ by installation of an Echo switch kit.

FIGURE 6

TREMULANT

The tremulant or tremolo is a periodic variation in intensity of all tones without change in pitch. It is produced by a variable resistance driven by the motor of the main tone generator, and is controlled by a variable resistor in shunt. When the tremulant control is turned as far as possible to the left, the tremulant is entirely off. As it is turned to the right (clockwise) the degree of tremolo gradually increases until it reaches a maximum at the extreme right position. The white dot marker on the knob indicates at a glance the degree of tremolo present. Two tremulant controls are used on the Model E console, one for each manual. These are controlled by separate levers located on the console. The tremulant is not incorporated in models having vibrato.

VIBRATO



FIGURE 7

The vibrato effect is created by a periodic raising and lowering of pitch, and thus is fundamentally different from a tremolo, or loudness variation. It is comparable to the effect produced when a violinist moves his finger back and forth on a string while playing, varying the frequency while maintaining constant volume.

The vibrato mechanism includes an electrical time delay line, which shifts the phase of all tones fed into it. A rotating scanner, mounted on the main tone generator, picks up successive signals from various line sections. These signals represent various amounts of phase shift, and the combination of signals produces a continuous frequency variation.

When the vibrato chorus switch (Fig. 7) (Models AV, BV, BCV, CV, DV, and RT) is pushed to the left, normal vibrato is obtained with the vibrato switch in positions 1,2, or 3. When the lever is pushed to the right a chorus or ensemble effect, combining foundation organ tone with vibrato tone, is obtained. The center position of this switch is not intended to be used. No harm will result from leaving the switch in this position, but reduced volume will be obtained.

Models B-2, B-3, C-2(G), C-3, RT-2, RT-3, A-100 & D-100 have the selective vibrato feature which makes the vibrato effect available on either manual separately or on both together. Two tilting tablets (Figure 3) control the vibrato for the two manuals, while the rotary switch selects the degrees of vibrato or vibrato chorus effect. The Great tablet controls the vibrato for the pedals as well as for the Great manual.

The vibrato is not present on models having the tremulant.

PERCUSSION



FIGURE 8

The Percussion feature (Models B-3, C-3, RT-3, A-100, and D-100) is controlled by four tilting tablets (Fig. 8) at the upper right side of the manuals. Percussion is available only on the upper manual and only when the B preset key is depressed. The four tablets (from left to right) select Percussion on or off, normal or soft Volume, fast or slow Decay, and second or third Harmonic tone quality.

Percussion tones are produced by borrowing the second or third harmonic signal from the corresponding manual drawbar, amplifying it, returning part of the signal to the same drawbar, and conducting the balance of the signal through push-pull control tubes where its decay characteristics are controlled.

The Percussion signal is then combined with the signal from the manuals after the vibrato but before the expression control. The control tubes are keyed through the eighth harmonic key contacts and busbar.

TONE GENERATOR

The main tone generator furnishes 82 or 91 different musical frequencies. depending on the console model. It includes a tone wheel, magnet, and coil for each frequency. Mounted on top of the generator are tuned filters to insure purity of the tones.

PREAMPLIFIER

The preamplifier is located in the console. Several types have been used in the various console models. Some obtain their plate voltage from the power amplifier through the console-to-cabinet cable, while others have a self-contained power supply.

TONE CABINETS

Tone cabinets are made in a number of models differing in size, finish, and power output. The numbers 20 and 40 in the model designations indicate the nominal power output in watts. Each tone cabinet includes one or two power amplifiers and two or more speakers.

Cables of special design are used to connect the console to the tone cabinet or cabinets.

REVERBERATION CONTROL

Tone cabinets having the letter R within the model designation are equipped with the Hammond Reverberation Control. This is an electro-mechanical device designed to supply reverberation for installations that are acoustically dead or have insufficient natural reverberation. A portion of the musical signal is delayed by passing through fluid-damped coil springs and then combined with the direct signal. By adjustment of the amount of delayed signal the reverberation characteristics of large or small enclosures may be simulated. A tone cabinet having this unit must be handled in accordance with directions on the instruction card in order to avoid damaging the unit or spilling the fluid.

ROTOR TREMULANT

Tone cabinets having the letter X in their model designation contain a drum rotor mounted above the speakers and driven by a small motor. Rotating in the path of sound from the loud speakers, it produces the effect of a periodic volume and pitch variation in all tones of the organ.

A switch for controlling its operation can be mounted on the tone cabinet, or an additional cable with a switch located at the console may be used. When a console having the Hammond Vibrato is connected to this type cabinet, use of the rotor tremulant is not recommended.

INSTALLATION AND MAINTENANCE

The organ must be connected to a regulated frequency source of the voltage and frequency specified on the name plate. If the frequency is not regulated the pitch of the organ will be irregular.

When a console is set up for operation the anchoring must be loosened so that the generator will float freely on its spring suspension system. No damage will result if this is not done, but the console will sound noisy, and the same is true if the anchoring is loosened but the console is not level. If the console is to be moved a long distance the anchoring should be tightened during such moves.

Several different types of anchoring have been employed and instructions for loosening and tightening the generator in any particular console are given on the instruction card contained in the bench which accompanied that console.

Each power amplifier has anchoring which should be loosened on installation and tightened for shipping. If the cabinet has a reverberation unit, it should be locked before moving the cabinet and the fluid should be removed as instructed on the card attached to the tone cabinet.

The tone generator is lubricated by putting oil into cups inside the console. It is recommended that each cup be filled three-fourths full, (1 tablespoon) once a year, using only the oil recommended for this purpose.

POWER AMPLIFIER

A-100

A twelve watt amplifier is mounted on the lower shelf of the console. It receives the signal from the Preamplifier and increases it in power to drive the two 12″ speakers.

D-100

A fifty watt three channel amplifier (bass with reverberation, treble, treble with reverberation) together with its independent power supply is located on the lower shelf of the console. It receives the signal from the preamplifier and furnishes power to drive the 2-12″ speakers and 2-8″ speakers.

C2-G

These consoles are identical in appearance to the C-2 and C-3 except that a monitor speaker is located on the lower left hand side. The preamplifier in the C-2G is designed to operate the monitor speaker. In the C-3G the preamplifier is the same as in the C-3. A small auxiliary amplifier drives the monitor speaker. In both Models, B+ voltage from the tone cabinet is required to make the monitor speaker operative. The HR-40G is identical to the HR-40 except that it is equipped with a standard 6 conductor cable which must be used in conjunction with the C-2G console.

REVERBERATION SYSTEM

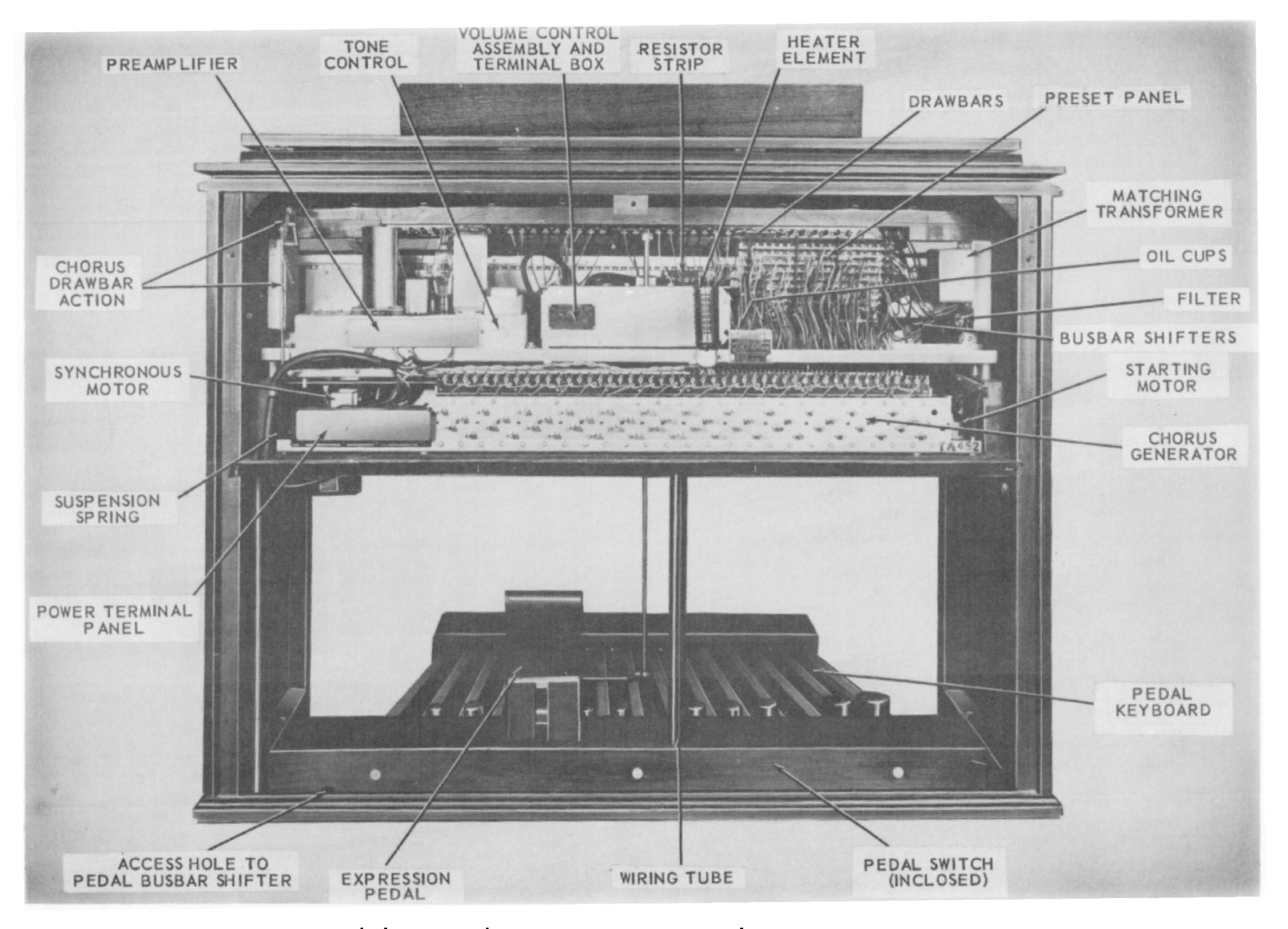
A-100

To the left of the amplifier are the reverberation amplifier and reverberation unit. A portion of the output signal of the power amplifier passes through the reverberation unit to the reverberation amplifier and this drives a third 12″speaker housed within the console. The degree of reverberation heard can be regulated by rotating the knob marked Reverberation Control located above the Vibrato tabs on the left side of the console.

D-100

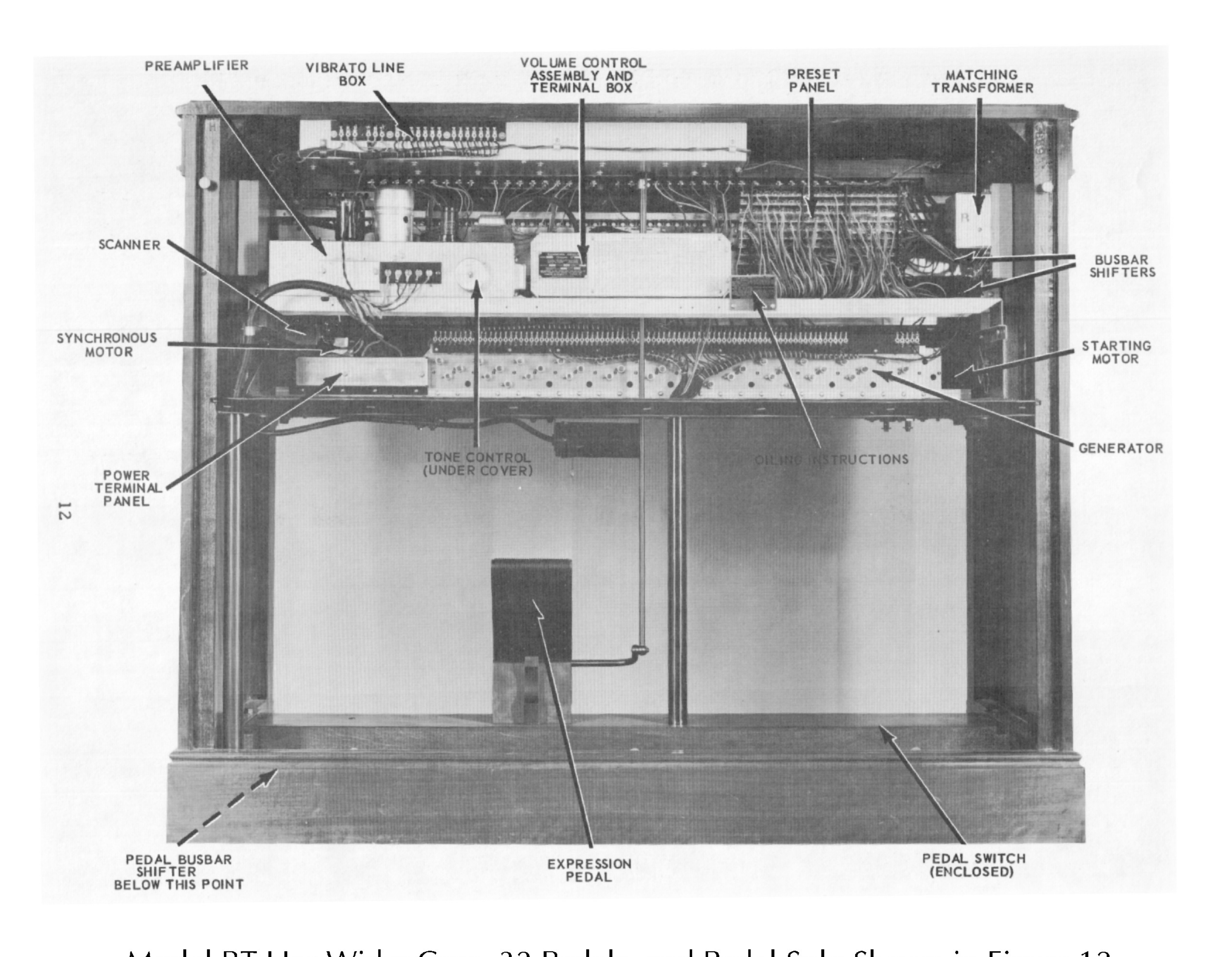
To the left of the pedal solo generator is the Hammond Reverberation unit. Signals from the preamplifier are applied to the treble with reverberation channel of the power amplifier and are heard from the 8″ speaker located to the right of the player.

In operation, an electrical signal from the reverberation drive channel is applied to the driver unit in the reverberation device which then converts the electrical signal into mechanical energy. This energy is transmitted through springs to a pickup unit where a part of it is converted back to electrical energy. The remaining portion is reflected back to the driver and again back to the pickup at a time interval determined by the spring lengths. This transaction continues until the signal energy is reduced to one millionth of its original value. The transfer time from driver to pickup and the reflections within the system itself produce the reverberation effect. The degree of reverberation heard can be regulated by rotating the knob marked Reverberation Control shown in Figure 5.



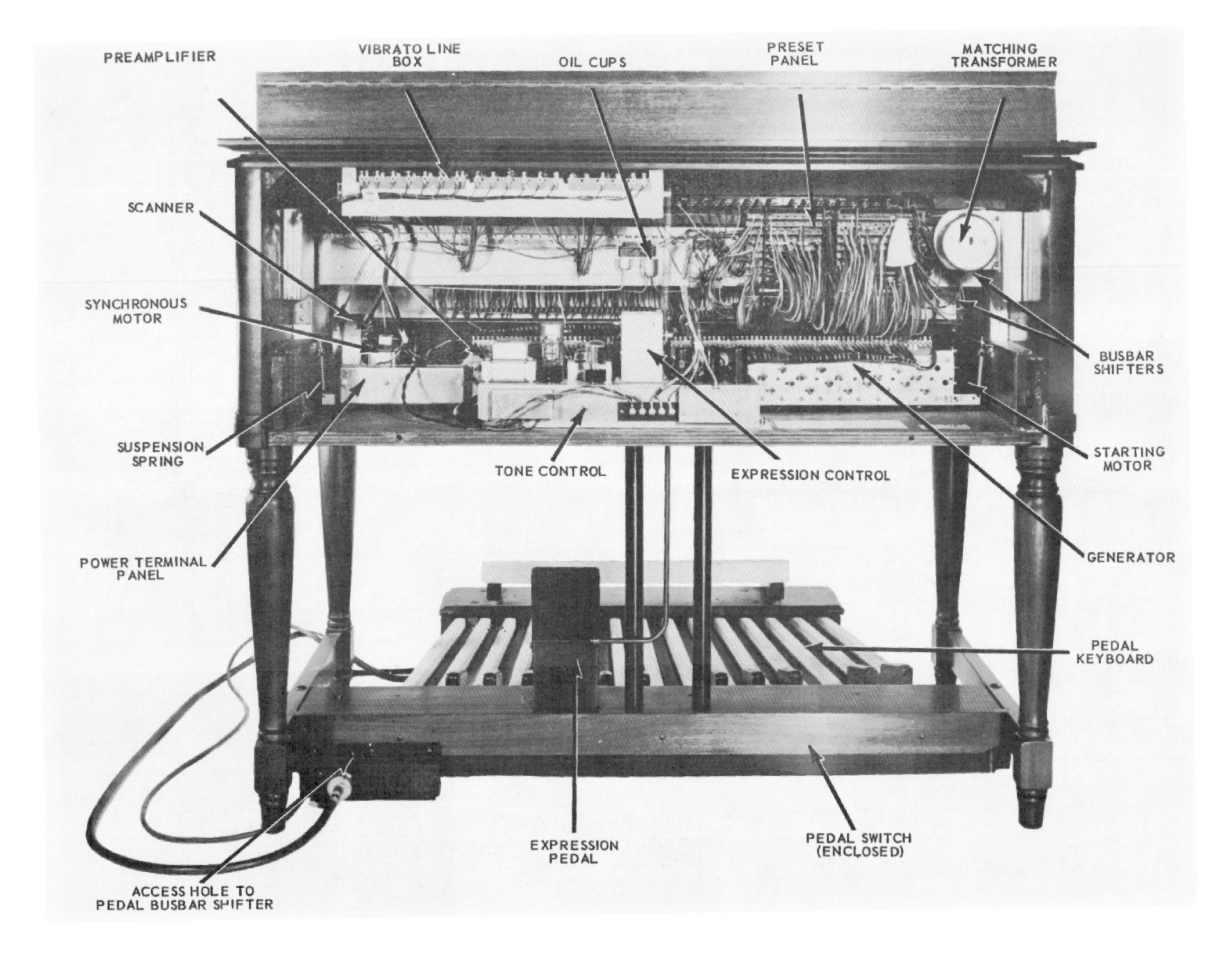
Models A and B Do Not Have Chorus Generator.
Where Vibrato Has Beed Added See Figure 10 For Parts Layout.

FIGURE 9 TYPICAL REAR VIEW OF CONSOLES WITH TREMULANT.



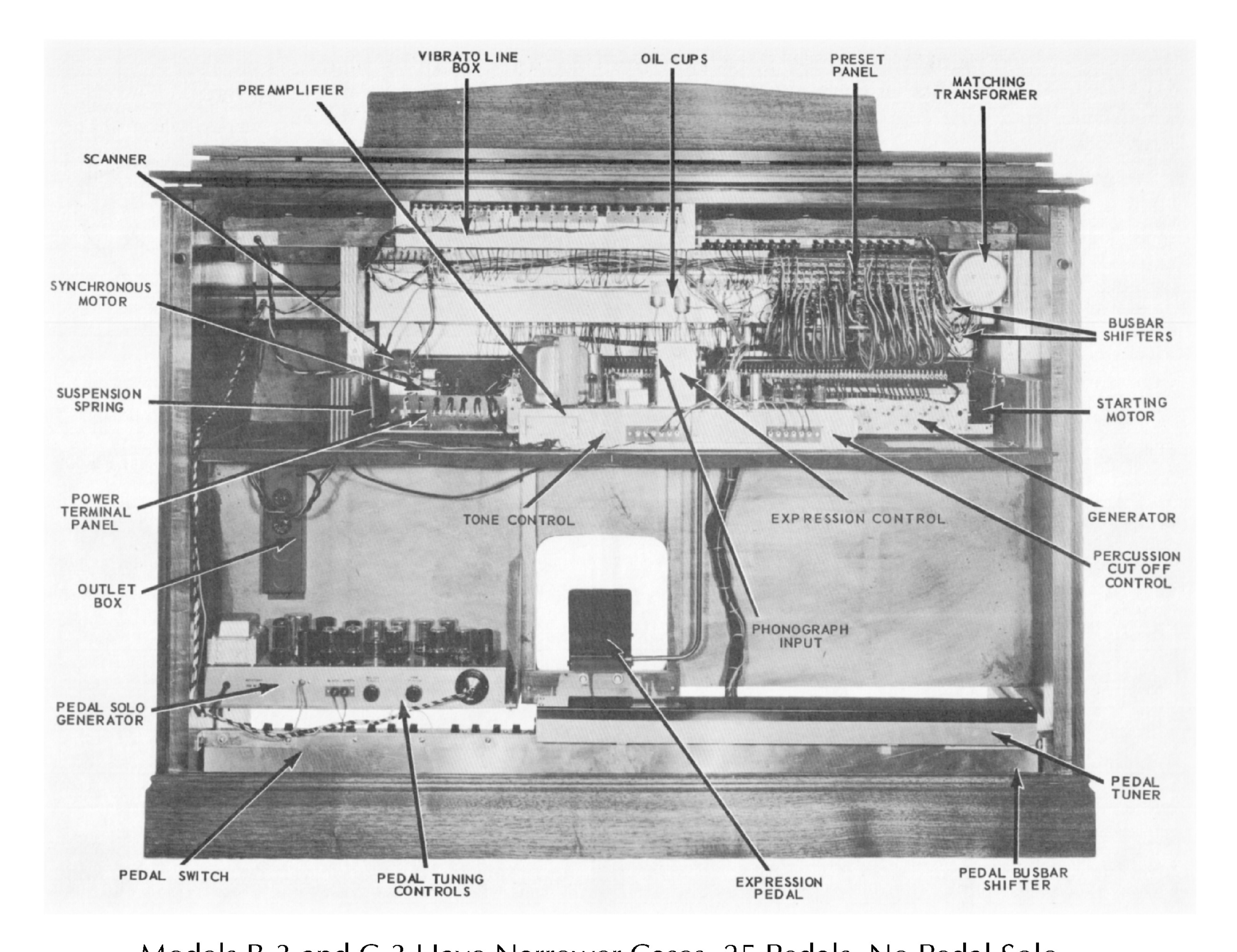
Model RT Has Wider Case, 32 Pedals, and Pedal Solo Shown in Figure 12.

FIGURE 10 TYPICAL REAR VIEW OF CONSOLES WITH VIBRATO.



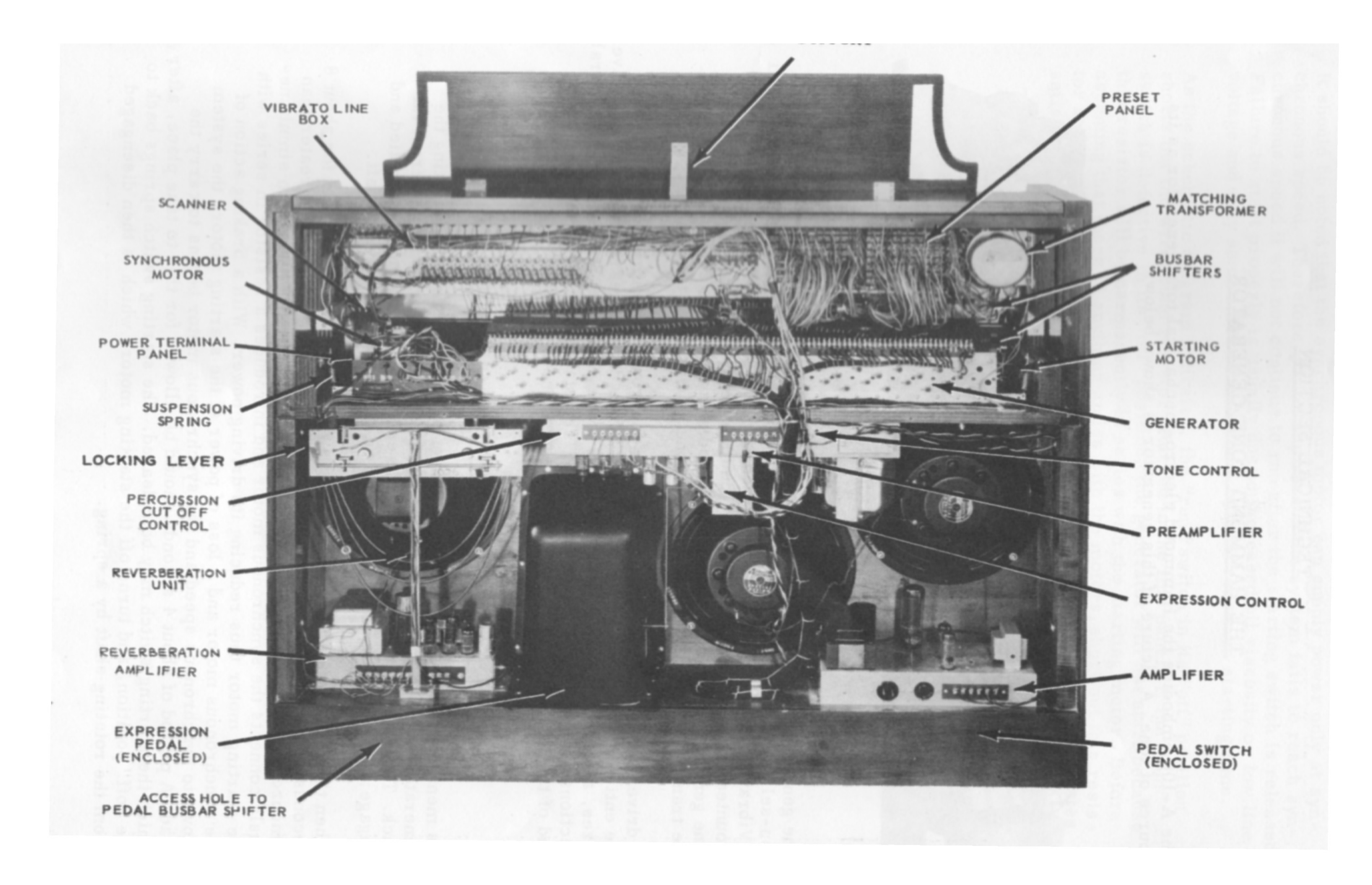
Model RT Has Wider Case, 32 Pedals, and Pedal Solo Shown in Figure 12.

FIGURE 11 TYPICAL REAR VIEW OF CONSOLES WITH SELECTIVE VIBRATO.

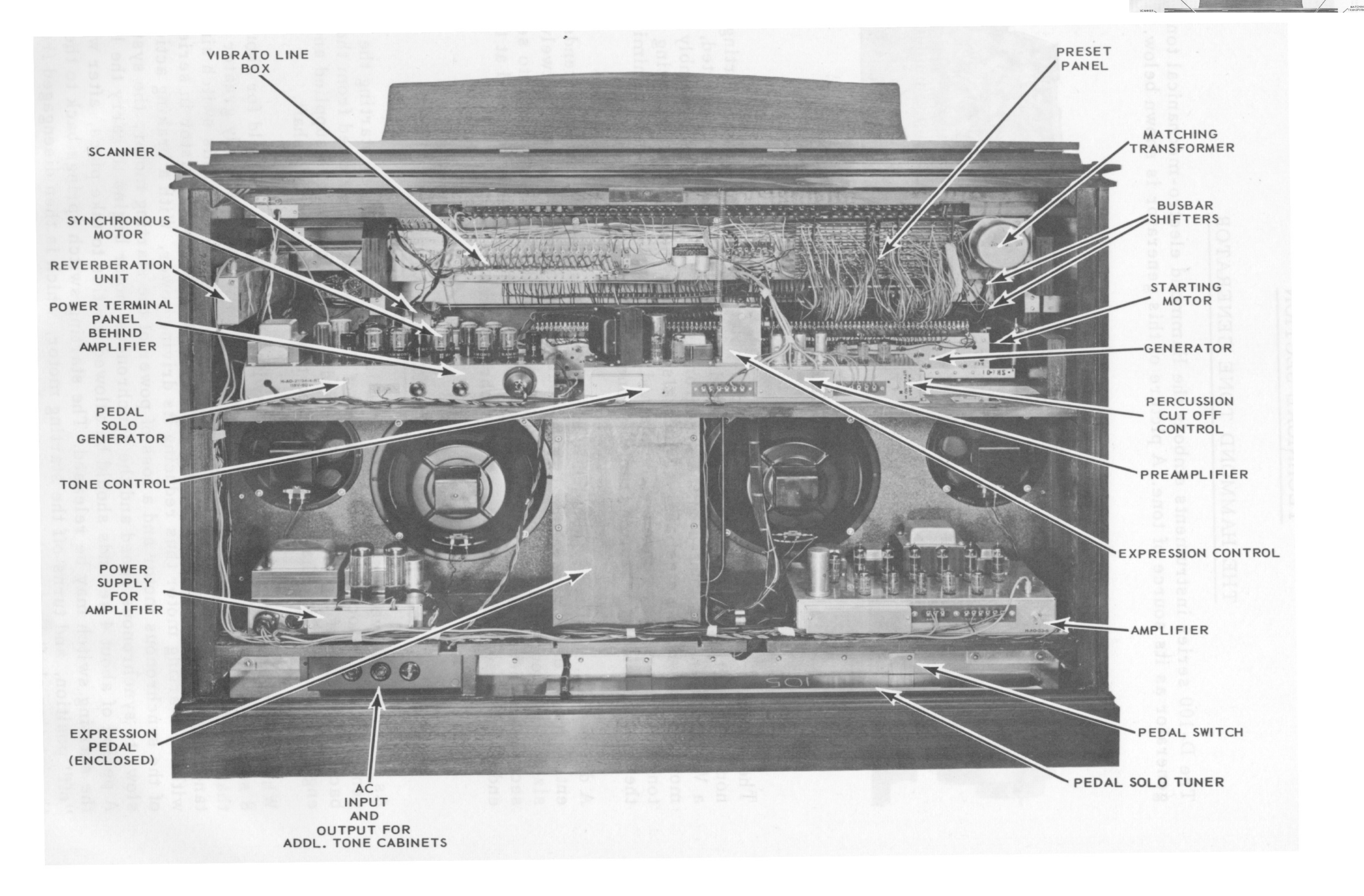


Models B-3 and C-3 Have Narrower Cases, 25 Pedals, No Pedal Solo.

FIGURE 12 REAR VIEW OF RT-3 (WITH PERCUSSION).



Typical Rear View of a Model A-100



Typical Rear View of a Model D-100

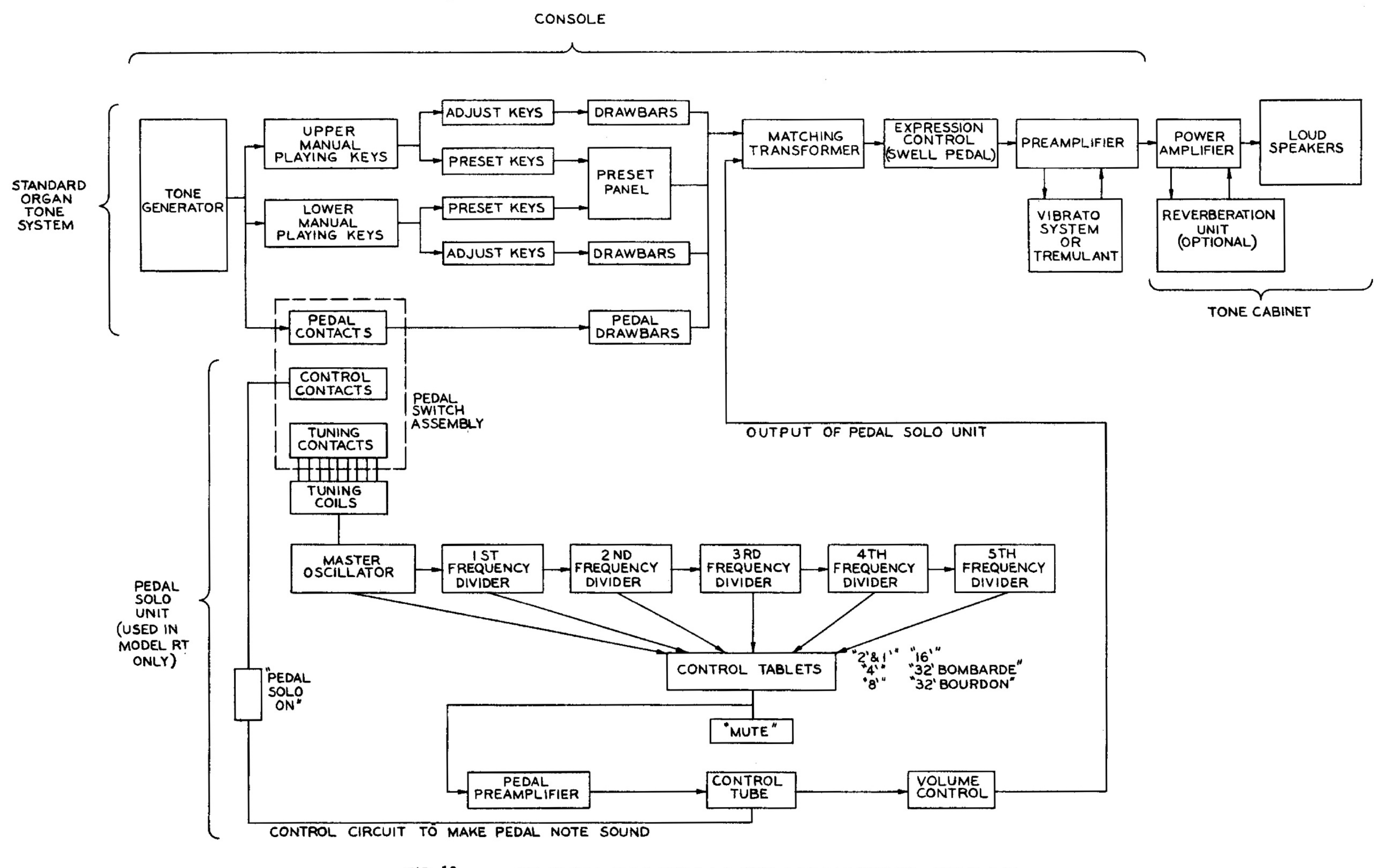


FIG. 13 – BLOCK DIAGRAM OF HAMMOND ORGAN MODEL A, B, BC, BCV, BV, C, CV, D, DV, G, RT

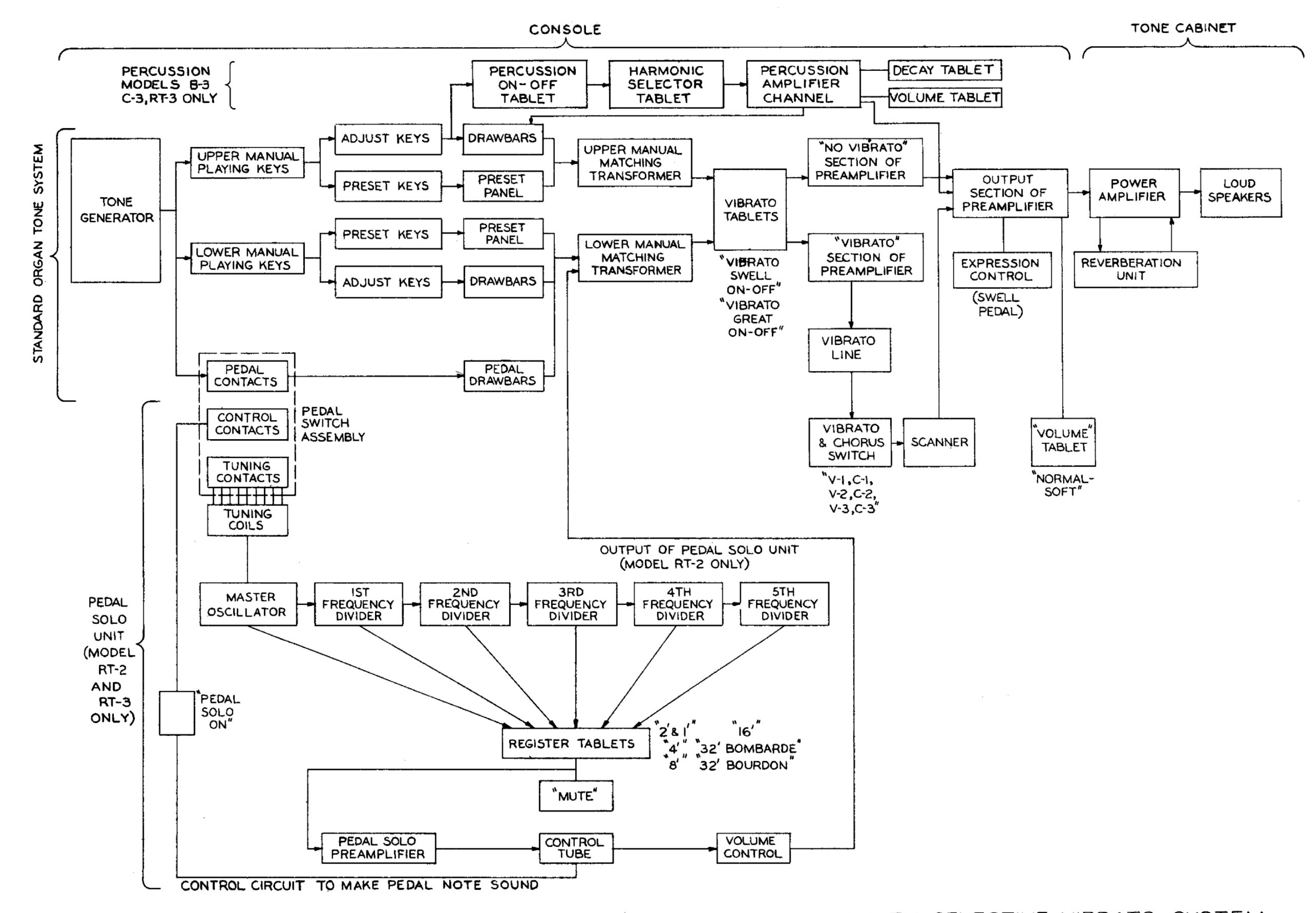


FIGURE 14-BLOCK DIAGRAM OF ORGAN MODEL B-2, B-3, C-2, C-3, RT-2, OR RT-3 WITH SELECTIVE VIBRATO SYSTEM

(B AND C MODELS DO NOT HAVE PEDAL SOLO UNIT)

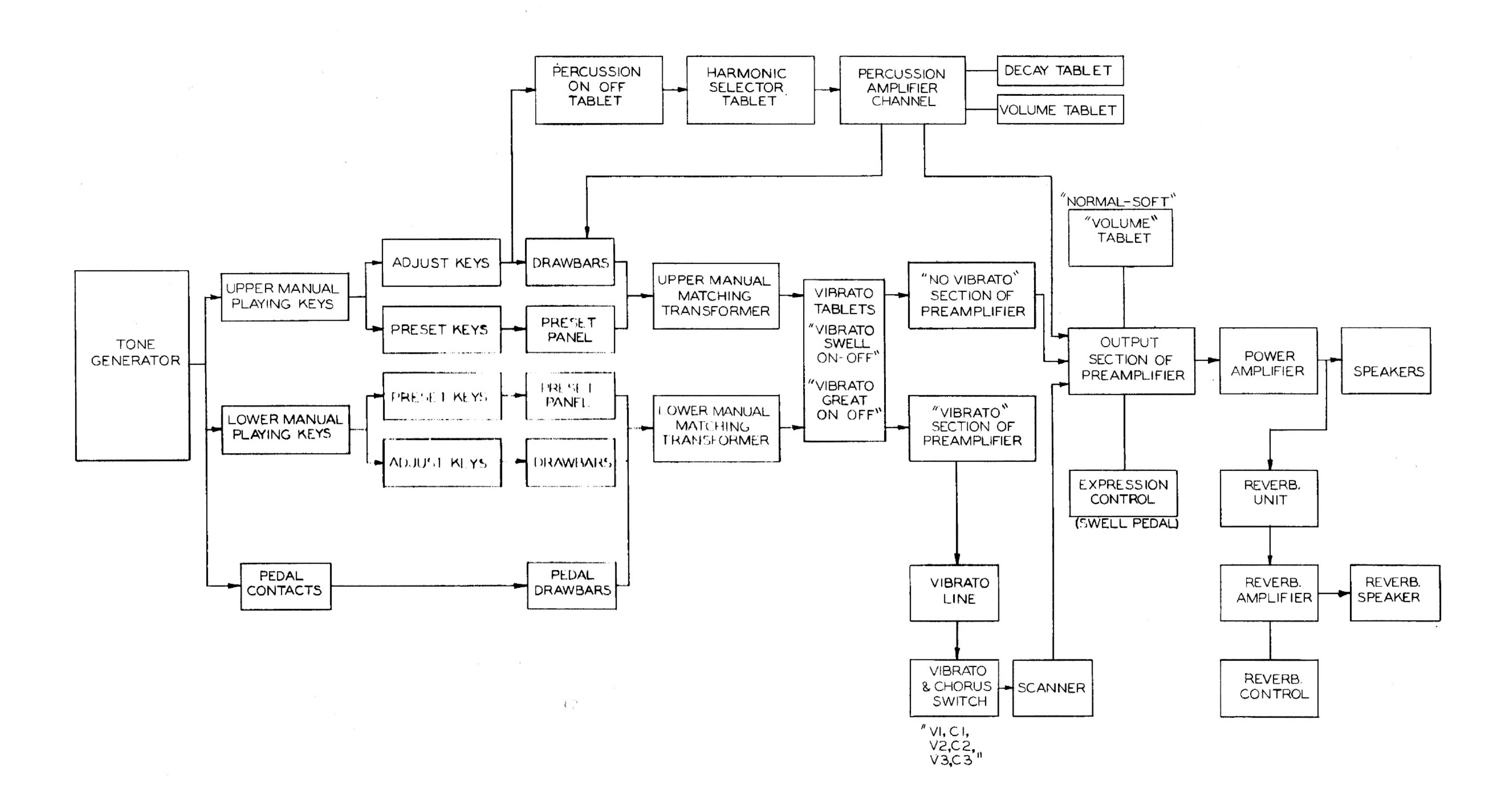


FIGURE 7 BLOCK DIAGRAM OF ORGAN MODEL A-100

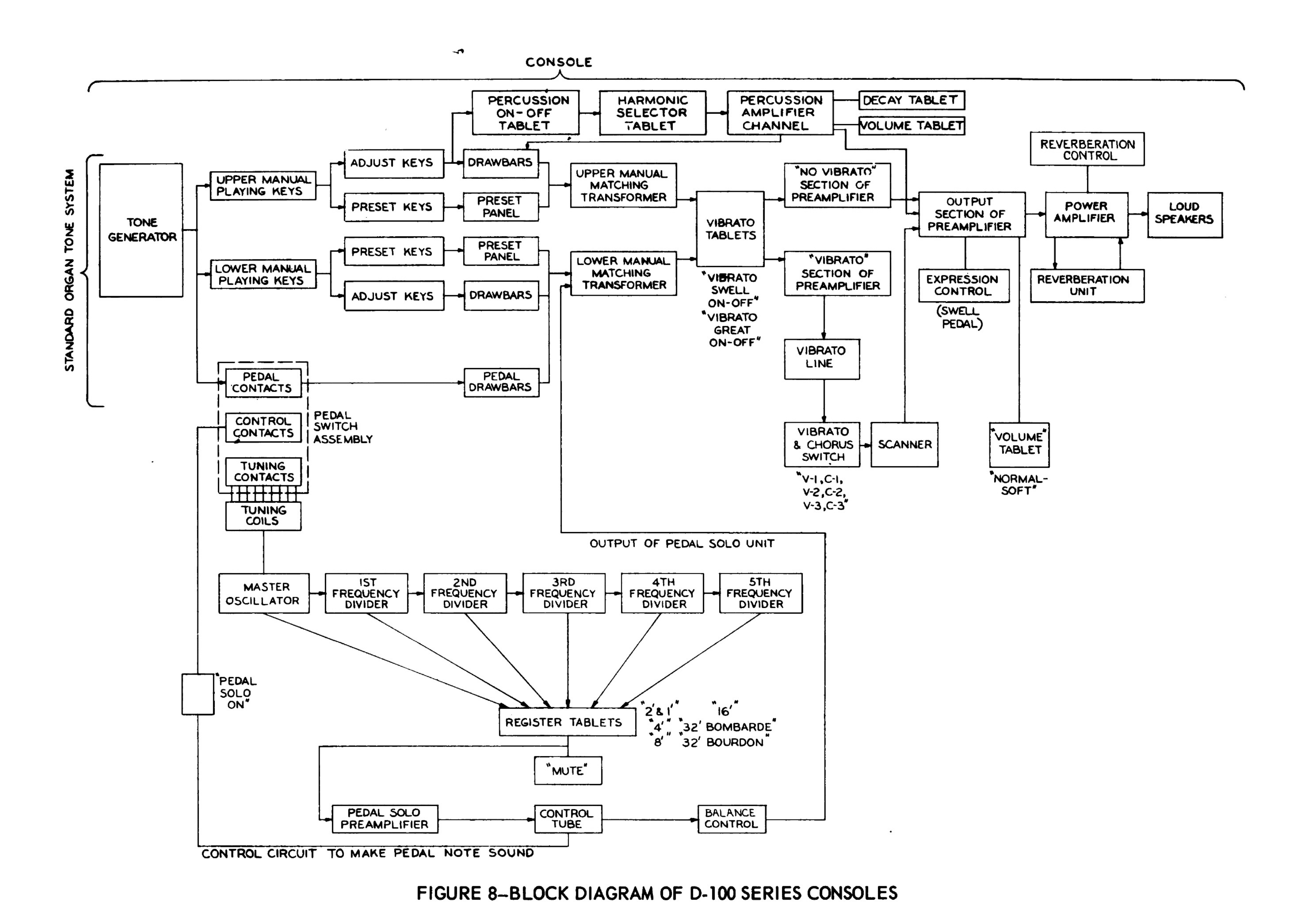
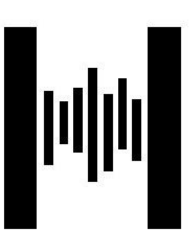


FIGURE 8—BLOCK DIAGRAM OF D-100 SERIES CONSOLES

THE HAMMOND ORGAN

– 3 –

ACOUSTICS



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

ACOUSTICS
THE PART THEY PLAY IN HAMMOND ORGAN INSTALLATIONS

INSTALLATIONS IN GENERAL:

The proper installation of a Hammond organ requires the careful observance of four primary rules:

1. The organ should furnish AMPLE POWER.
2. The sound energy from the organ should be EVENLY DISTRIBUTED.
3. The console and tone cabinets should be so located in relation to each other and to the audience, choir, soloist, etc., that a PROPER TONAL BALANCE is accomplished.
4. The organ tone should be PROPERLY REVERBERATED.

The observance of these rules with due consideration to the particular use for which the instrument is required will insure the best possible installation in any type of enclosure. These rules will be discussed in detail in the following pages.

POWER

There are so many factors which have a bearing on the amount of power or sound energy necessary for best musical results in a given enclosure that an accurate formula for determining the required power in all cases would be too cumbersome for everyday use. Experience has shown that it is very seldom that too many tone cabinets are specified. Therefore, if there is doubt as to the sufficiency of tone cabinets for any installation it is reasonably safe to double this amount. This will greatly improve the musical quality of the instrument and eliminate overloading of the speakers. Some of the factors which have a bearing on the amount of tone cabinet equipment required in any enclosure are the size and shape of the enclosure, placement of tone cabinets, amount and location of sound-absorbing materials including persons present in the enclosure. The use for which the organ is desired also has a bearing on requirements; for example, an organ to be used primarily to support congregational singing would require more tone cabinets than one that is to be used mainly for accompaniment of soloists or light entertainment.

The following conditions in an enclosure, therefore, usually indicate that more than an average installation may be required:

1. When the area of the boundaries of the enclosure is great in proportion to the volume of the enclosure. Thus, an enclosure of irregular shape having numerous alcoves, etc.,would require more tone cabinets than one of cubical shape.
2. When the tone cabinets are located in a position where considerable sound absorption takes place before the music reaches the listener. A poorly designed or constructed organ chamber is an example.
3. When acoustical correction materials are used on walls or ceiling, when heavy drapes are present and carpets are used for floor covering.
4. When seating capacity is high for the size of the enclosure. For practical purposes an open window is considered as an area of 100 percent absorption of sound. A single person absorbs about as much sound as four square feet of open window. Therefore, an audience of 1,000 people will have the effect on music volume of an open window area of 4,000 square feet as compared with the volume heard when the enclosure is empty. To offset this absorption, a disproportionately greater amount of tone cabinet equipment must be used.

DISTRIBUTION

The sound energy from the organ should be distributed as evenly as possible throughout the enclosure. In order that this may be accomplished, it is important that the sound be distributed in the auditorium above the listeners and that a large percentage of the sound reaching the listener is by numerous reflections from the walls and ceiling. Direct projection as well as direct reflection from the speakers should not reach the listener. Focusing effects of curved surfaces such as barreled ceilings often cause difficulty in sound distribution unless the tone cabinet is so located as to reduce the direct sound energy that reaches these surfaces.

It must be remembered that although sound is reflected in a manner similar to light, the reflecting surface must be large in relation to the wave length of the sound. Therefore, a reflecting surface of a given size will reflect sounds above a certain frequency, while sounds of lower frequency will be diffracted or spread out. To reflect fully the lower tones of the organ a reflector thousands of square feet in area is necessary. This, together with the fact that different materials absorb sounds of certain frequencies more than others explains why identical tone colors produced in different enclosures will sound very different to the ear.

BALANCE

The placement of console and tone cabinets should be carefully planned so that the following conditions are fulfilled:

1. The organ should sound as loud or slightly louder to the organist at the console than it does to the audience. This allows the organist to accurately judge the musical effect he is producing and make any necessary corrections before the audience appreciates the need for them. It also reduces the tendency of playing too loud which is usually evident when the organist hears the organ at a lower level than the audience.
2. The organist should hear the organ and the choir with the same relative loudness that the audience hears them, otherwise a perfect tonal balance between organ and choir from the organist's point of hearing will result in an unbalanced effect as heard by the audience. When we refer to the choir we also include instrumental groups or soloists who may have occasion to perform in conjunction with the organ.
3. The tonal equipment of the organ should be so located that the choir, while singing, has adequate support from the organ when played at accompaniment volume. They should not, however, hear the organ so loudly as to have difficulty in singing with it. Good tonal balance and ease of performance should result if the average distance between choir and tone cabinets is about the same distance as between tone cabinets and organist.
4. The audience should hear the choir and the organ as a balanced ensemble, and the tone cabinets should be so placed that the choir voices will not be obscured by the organ tones.

REVERBERATION

Reverberation is the prolongation or persistence of sound by reflection, what we usually mean by echo. It is measurable by the interval of time required for the sound to decay to inaudibility after the source of the sound has been stopped. It is present in a varying degree in all enclosures and most types of music are more pleasing to the ear when accompanied by a certain amount of reverberation.

It is also the most important single factor to be considered in planning an organ installation as proper reverberation makes it easier to attain all of the other requirements necessary for a perfect installation.
In a Hammond organ installation, the proper amount of reverberation may be secured in three ways:

1. By the successive reflections of the sound by the boundaries of the auditorium.
2. By the Hammond Reverberation Control.
3. By placing the tone cabinets in a chamber, the boundaries of which cause the organ tones to reverberate before reaching the auditorium.

REVERBERATION IN THE AUDIITORIUM

The reverberation that results from the successive reflections of sound back and forth by the boundaries of the auditorium itself is most desirable from the installation engineer's point of view. (By auditorium we mean any audience room such as a church or concert hall.)

In a reverberant auditorium less power is necessary and problems of sound distribution are greatly simplified and, therefore, the best possible musical results are usually obtained as a matter of course. Unfortunately, however, the reverberation characteristics of an auditorium usually are not alterable by the installation engineer, and he must accept them, good or bad as the case may be.

A reverberation time of one second when a two-thirds capacity audience is present is usually sufficient if reasonable care is taken in locating the organ equipment for proper distribution and balance although a slightly longer reverberation time is often desirable. It must be remembered that the reverberation time in any enclosure is greatly reduced when an audience is present. In general, the higher the ceiling of the auditorium, the less effect the presence of an audience has on the reverberation time; however, this effect is always considerable. If the natural reverberation in the auditorium is insufficient for best musical results from the organ, another method must be used to properly reverberate the organ tones.

HAMMOND REVERBERATION CONTROL

The Hammond Reverberation Unit provides an effective means of securing proper reverberation in all types of installations where the natural reverberation in the auditorium is insufficient. Experience has shown that best installations in homes, radio studios, mortuaries, and small churches include a tone cabinet equipped with reverberation control. It may also be used to improve the effectiveness of the organ in auditoriums where considerable natural reverberation is present, but where this natural reverberation is characterized by an objectionable echo occurring after the organ tones have seemingly ceased. The Hammond Reverberation Unit will not eliminate an echo or reduce the natural reverberation time, but will often make this natural reverberation more pleasing to the ear by filling in that period between the time the organ tones seem to cease and the echo occurs. The Hammond Reverberation Unit will not add to the reverberation time in auditoriums already having excessive natural reverberation. As the reverberation unit is connected to the electrical system of the organ and provides reverberation at the source of sound rather than after the sound comes from the speakers, it allows the installation engineer to place the tone cabinets for best results in balance and distribution without the necessity of compromise for reverberation considerations.

The use of this device also eliminates the necessity of costly reverberation chambers, and by allowing the tone cabinets to be so located as to minimize sound energy losses, a saving in the amount of necessary power equipment is often effected. A further advantage is that the reverberation time may be regulated for best musical results after the organ is installed. With the use of the Hammond Reverberation Unit a good organ installation should always result if the tonal equipment is placed to give even distribution and proper tonal balance.

REVERBERATION CHAMBERS

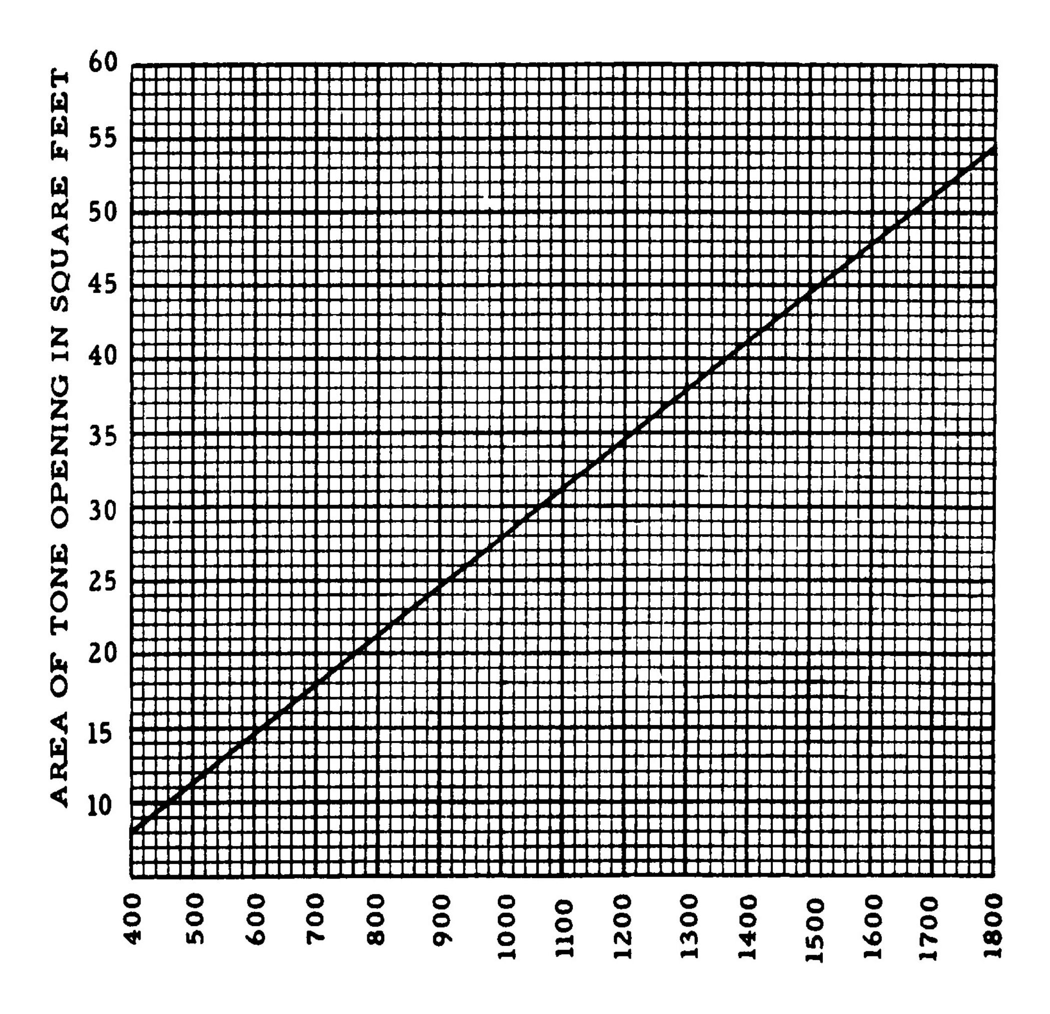
When it is desired to conceal the organ tone cabinets and there is adequate space available, a properly designed reverberation chamber may be very effective in supplying reverberation for the organ tones. In many cases, however, the space allotted for use as a reverberation chamber is anything but ideal, and often, because of structural limitations, little can be done to improve the effectiveness of the chamber other than to make minor corrections. The following principles of reverberation chamber design are given for guidance in properly evaluating the good and bad characteristics of a given chamber and in making such changes as will improve the effectiveness of the chamber as much as possible.

SIZE

As the reverberation time increases as the size of the chamber increases, the chamber should be as large as possible. Experience has shown that practically the only exceptions to this rule are when the shape of the chamber may be improved by reducing its size or when the tone opening cannot be made large enough in proportion to the size of the chamber. For best musical results the chamber should be at least 800 cubic feet in volume. The dimensions of the chamber are in most cases ideal if they are in the ratio of approximately 2 : 3 : 4 ½. A chamber of equal volume but more cubical in form would have a longer reverberation time, while a chamber of less cubical form would have a shorter reverberation time; however, dimensions in the above ratio usually are most desirable. Chambers of complex shape or chambers of regular shape whose greatest dimension is more than three times the least dimension should be avoided.

CHART SHOWING SIZE OF TONE OPENING REQUIRED FOR REVERBERATION TIME OF ONE SECOND

FOR CHAMBERS WITH DIMENSIONS IN RATIO OF 2 : 3 : 4.5



VOLUME OF CHAMBER IN CUBIC FEET
FIGURE 1.

<u>CONSTRUCTION AND FINISH</u>

All boundaries of a reverberation chamber should be of exceptionally rigid construction. Concrete or heavy t1le is ideal. If the chamber is to be of frame construction the studs should not be over fourteen inches on centers. Lath should be very securely nailed and the plaster should be hard and given a smooth finish coat.

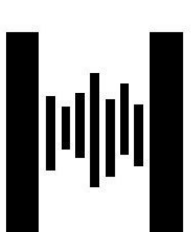
<u>TONE OPENINGS</u>

The reverberation time of an organ chamber is greatly influenced by the size of the tone opening. For a chamber of given dimensions, the reverberation time is increased as the area of the tone opening is reduced. A large chamber, therefore, may have a large tone opening and still furnish sufficient reverberation, whereas a small chamber might require a very small opening. A chart is shown in Figure 1, giving the area of tone opening required to furnish one second reverberation time when the volume of the chamber is known. This chart is for chambers with dimensions in the ratio of 2 : 3 : 4 ½ only; however, in practice the areas of tone opening shown are generally satisfactory. The tone opening should be located in the largest wall surface of the chamber if possible, and preferably near the center of the wall area.

THE HAMMOND ORGAN

– 4 –

CABLES & PLUG ASSEMBLIES
&
CABLE CONNECTION DIAGRAMS



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

CABLES

Each console is shipped from the factory with cables sufficient for an ordinary installation having a single tone cabinet. It has a 15 foot 2 conductor line cord for connecting to an AC wall outlet, and a 35 foot console-to-cabinet cable (6 conductor or 5 conductor, depending on the console model) to connect to the first power amplifier. In case the console is located an unusually long distance from the tone cabinet, additional 6 or 5 conductor cable must be ordered. If the console has an echo switch, a 5 conductor cable of the required length must be ordered separately to connect it to the echo tone cabinet. (See Echo Organ Wiring, on page 3 of this section).

For installations having two or more tone cabinets, cable suitable in length must be secured to connect between cabinets. Each power amplifier has a 6 pole input plug and a 5 pole coupling receptacle for connecting additional amplifiers.

TYPES OF CABLES USED

6 Conductor console-to-cabinet cable used onion models A, B, AB, BC, BCV, BV, C, CV, D, DV, E, G, RT. This is used only between these models of consoles and the first power amplifier, and has a 6 pole plug at one end and a 6 pole receptacle at the other. It consists of two AC wires, two grid (signal) wires, a B plus wire to carry plate current from the first power amplifier to the console preamplifier, and a ground (signal return) conductor, which is actually a shield over the B plus wire. This cable is especially designed for use with the Hammond Organ and is approved by the Underwriters Laboratories for that purpose.

5 Conductor console-to-cabinet or cabinet-to-cabinet cable. This is identical to the 6 conductor cable except that it has no shield and one end has a 5 pole plug instead of a 6 pole plug. It has no B + conductor, the fifth wire being used for ground. It is used for carrying power and signal between amplifiers, since a B + connection is never needed beyond the first power amplifier; to connect an echo cabinet, since in this case also no B + connection is required; and as a console-to-cabinet cable for models where the console preamplifier has its own power supply. In case 5 conductor bulk cable is not available, a 5 conductor cable assembly may be made from 6 conductor bulk cable, using the shielded wire for ground and leaving the shield disconnected. NOTE: 5 conductor console -to-cabinet cable is used with Models B-2, B-3, C-2, C-3, RT-2, RT-3, A-100, and D-100.

3 Conductor cabinet -to -cabinet cable. This is used for carrying only the signal between amplifiers, and is used for connecting cabinets when external AC power circuits are employed. It is standard 3 conductor indoor telephone cord and has 5 pole plugs on both ends. A cable may be made up with a number of plugs along its length in order to connect several cabinets together. This wire can be secured from your local electrical jobber.

2 Conductor line cord. This supplies AC power to the console and has a standard attachment plug on one end and a standard attachment receptacle on the other.

2 Conductor cabinet power cord. This is used to furnish AC power to additional power amplifiers, when the signal is supplied through a 3 conductor signal cable. It has a standard attachment plug at one end and a 6 pole receptacle at the other.

For permanent installations, when the cables are to be installed in conduit, special Jones fittings manufactured by the Cinch Manufacturing Company are obtainable through your electrical supplier. Those recommended for console location are:

1-5406 - CCE 6 prong socket
1-P406-WP 6 prong plug with wall plate

For each tone cabinet location:

1-P406 - CCE 6 prong plug
1-5406 -WP 6 prong socket with wall plate

BLOCK DIAGRAMS

Figure 1 is a simplified diagram showing how the console is connected to a single tone cabinet or group of cabinets drawing not over 620 watts input. This is the maximum AC power which can be supplied through the console without damaging the console switch or wiring. The name plate on each cabinet shows its wattage rating.

If the tone cabinet power requirements exceed 620 watts. some of the cabinets must be supplied from a separate AC source as indicated in figures 2 and 3. Figure 2 is the preferred method, employing a relay to turn on the additional cabinets. The relay must have a coil of the same voltage and frequency rating as the organ, and must have contacts suitable for carrying the amount of power drawn by the additional cabinets. Allen-Bradley Bulletin 700 relays are suitable for this purpose and may be obtained from your electrical supplier.

When the AC power is supplied separately to additional cabinets. as in figures 2 and 3, a 3 conductor cable is sufficient to carry the signal between cabinets.

DETAILED WIRING DIAGRAMS

Figures 4,5, and 6 are detailed versions of figure 1. In figure 4 the console is connected to one tone cabinet having a single amplifier. and figure 5 shows connections to a cabinet with two power amplifiers. connected together by a 5 conductor coupling cable. Additional amplifiers up to a maximum of 620 watts AC input, may be connected as shown in Figure 6.

Figure 7 is a detailed diagram of the arrangement in figure 2. The 3 conductor cable carries signal to all cabinets. while each cabinet has its own AC power cord. In this case the 6 pole input plug in each additional cabinet is used for power input only. and the signal is fed, into the 5 pole coupling receptacle.

A switch may be connected in place of the relay contacts to convert this circuit to the arrangement of Figure 3.

ECHO ORGAN WIRING

Some desirable musical effects may be secured by an echo tone cabinet installed at a location some distance from the main cabinet or cabinets. As indicated in the block diagram, Figure 8, an echo switch on the console controls only the tone cabinet signal circuits, and all cabinets remain energized so that they will sound instantly when desired. Figure 9 shows the cable connections required.

REVERBERATION EQUIPMENT

Some types of tone cabinets have reverberation units and reverberation preamplifiers built into them. In this case, see the instruction card attached to the cabinet for correct cable connections. While there are several different styles of wiring, it will be found that every cabinet has a 6 pole input plug and a 5 pole output receptacle for connecting additional amplifiers. Some reverberation preamplifiers employ a special detachable coupling cable, wired as shown at the bottom of Figure 10.

In reverberation-equipped tone cabinets type CR-20, DR-20, ER-20, FR-40, and G -40, reverberation is applied to all organ frequencies. In this case only one reverberation unit is required for any installation, no matter how many tone cabinets are used. The reverberation unit should be in the cabinet which is connected directly to the console, in order that reverberated signal may be supplied by it to all other cabinets.

In multi-channel tone cabinets type JR-20, HR-40, KR-40, PR-20, PR-40 and QR-40 a reverberated signal is not available to drive succeeding cabinets. For this reason an installation using several such cabinets must have a reverberation unit in each cabinet if it is desired that reverberation be present in all cabinets.

It is not recommended that multi-channel cabinets be driven by a reverberated signal from a preceding cabinet because irregularities in the bass response of the reverberation system may be emphasized by the bass amplifier channel. In case one of these cabinets is to be used with one or more reverberation cabinets of other types, it should be connected directly to the console, with the other cabinets following it in the usual way.

Further information on types of reverberation equipment will be found in the section dealing with this item.

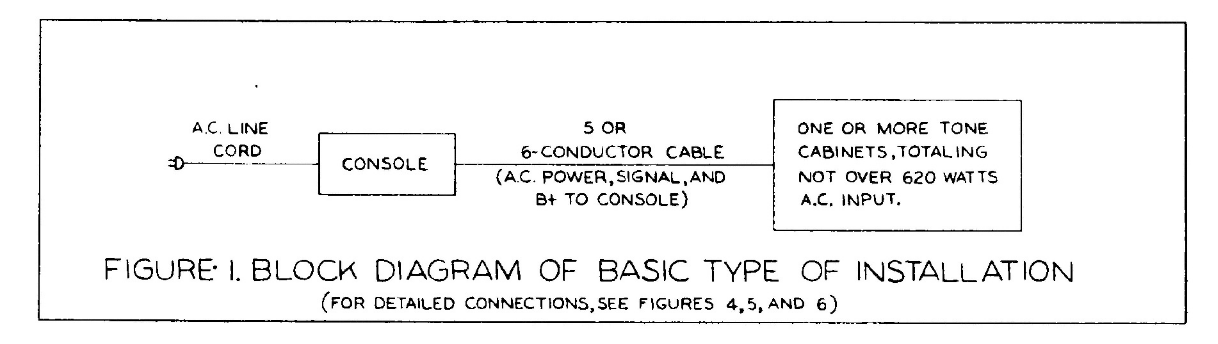


FIGURE 1. BLOCK DIAGRAM OF BASIC TYPE OF INSTALLATION
(FOR DETAILED CONNECTIONS, SEE FIGURES 4, 5, AND 6)

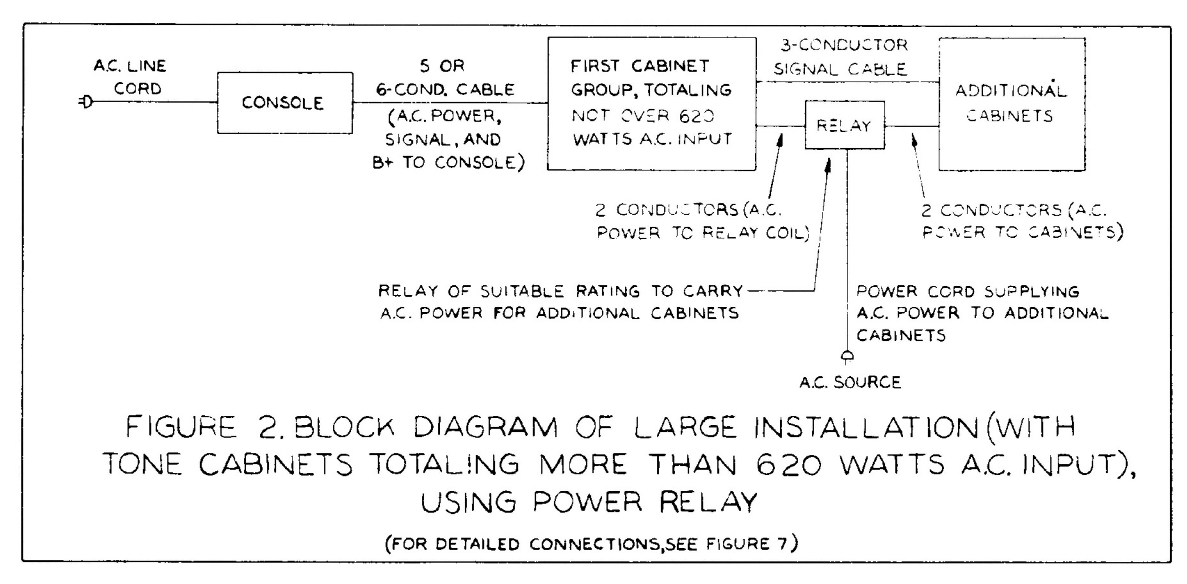


FIGURE 2. BLOCK DIAGRAM OF LARGE INSTALLATION (WITH TONE CABINETS TOTALING MORE THAN 620 WATTS A.C. INPUT), USING POWER RELAY
(FOR DETAILED CONNECTIONS, SEE FIGURE 7)

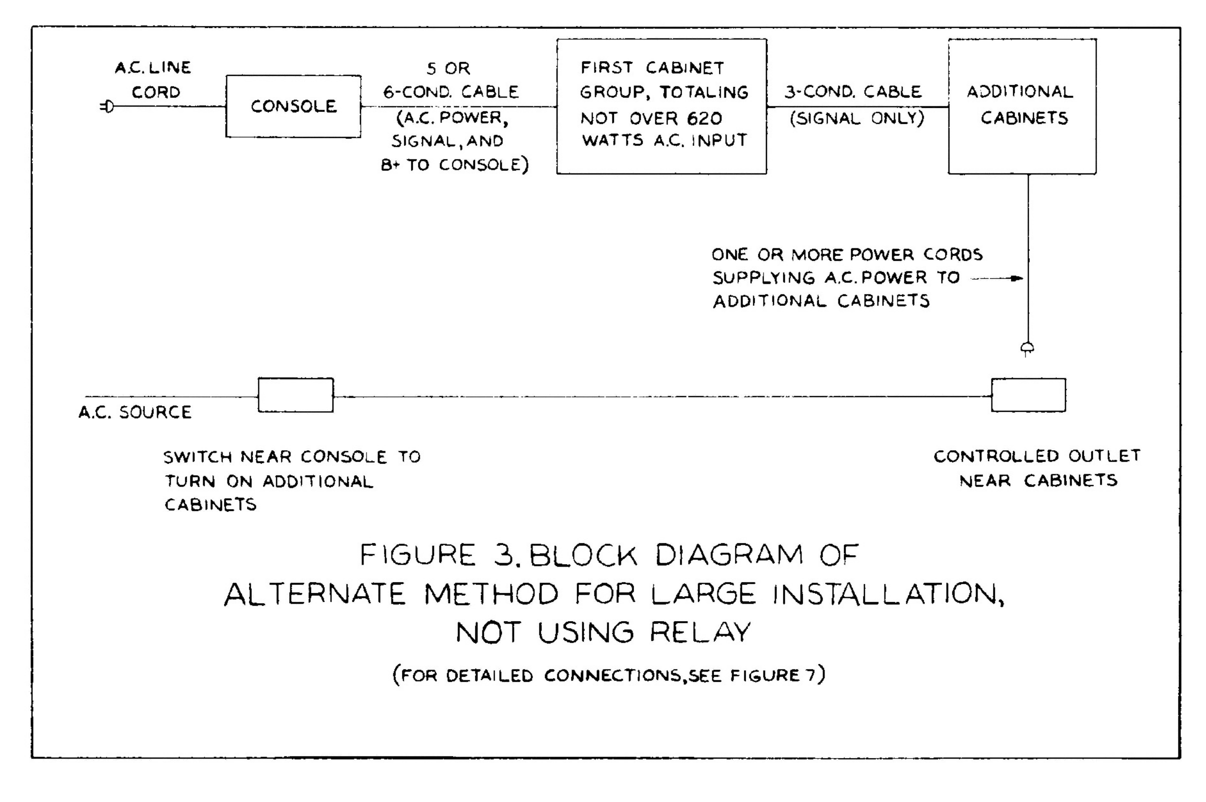


FIGURE 3. BLOCK DIAGRAM OF ALTERNATE METHOD FOR LARGE INSTALLATION, NOT USING RELAY
(FOR DETAILED CONNECTIONS, SEE FIGURE 7)

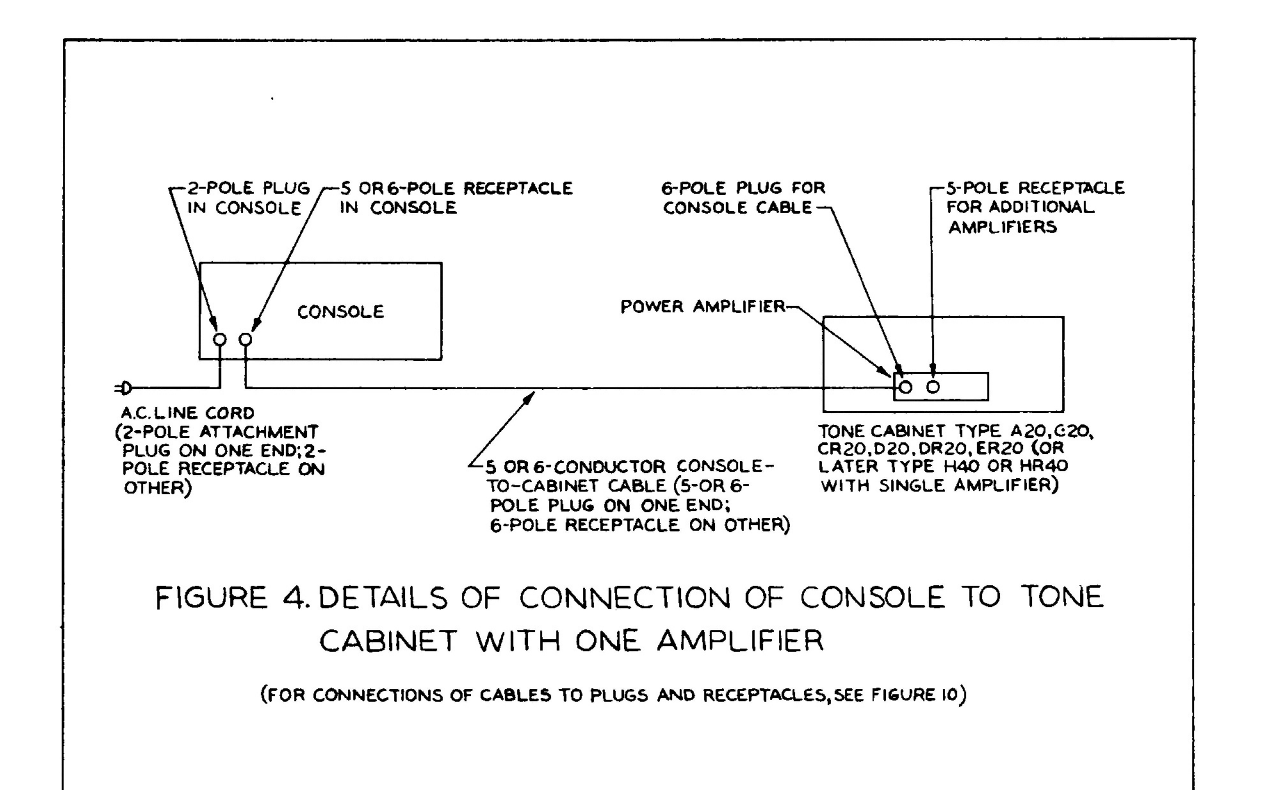


FIGURE 4. DETAILS OF CONNECTION OF CONSOLE TO TONE CABINET WITH ONE AMPLIFIER

(FOR CONNECTIONS OF CABLES TO PLUGS AND RECEPTACLES, SEE FIGURE 10)

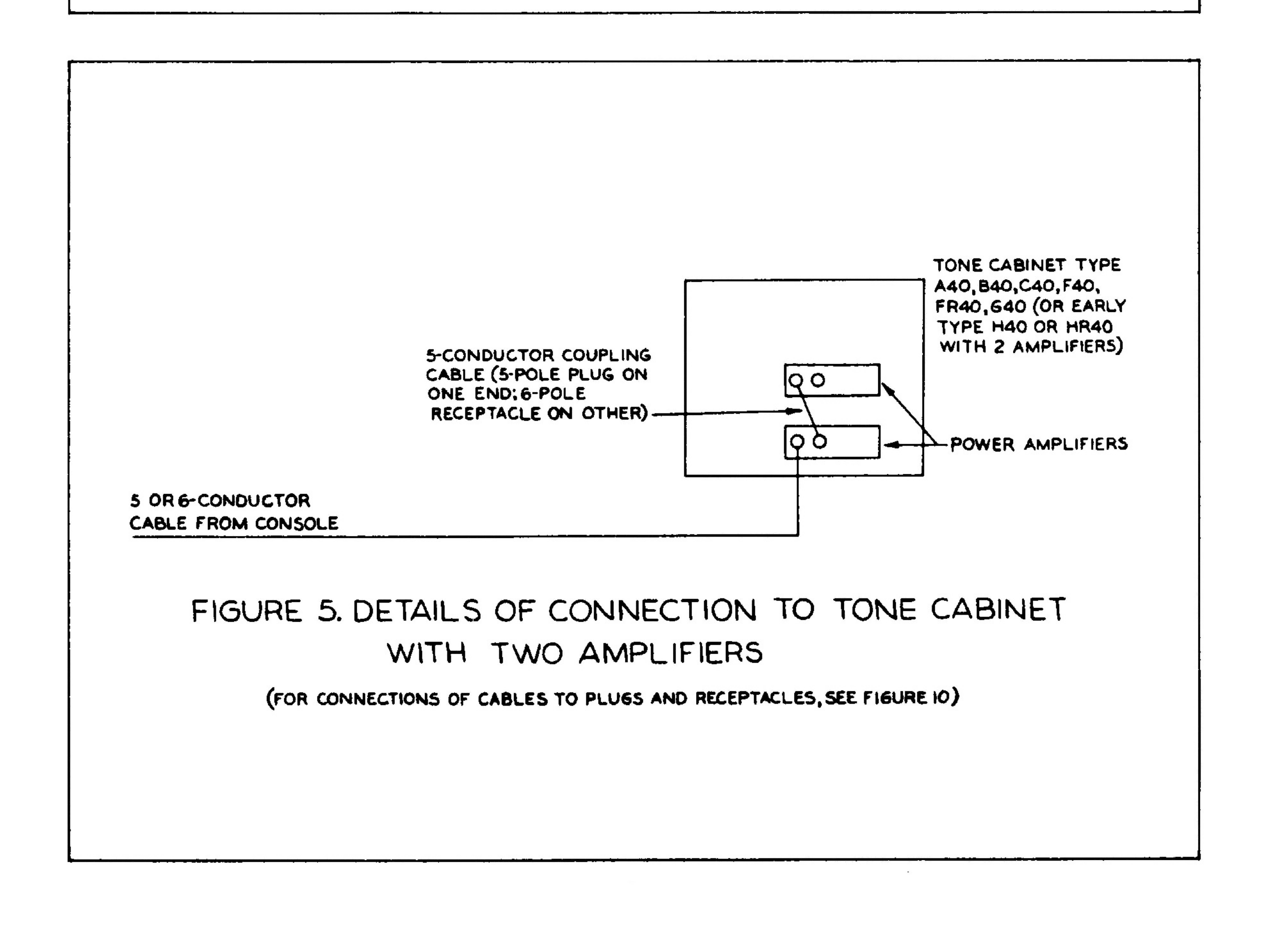


FIGURE 5. DETAILS OF CONNECTION TO TONE CABINET WITH TWO AMPLIFIERS

(FOR CONNECTIONS OF CABLES TO PLUGS AND RECEPTACLES, SEE FIGURE 10)

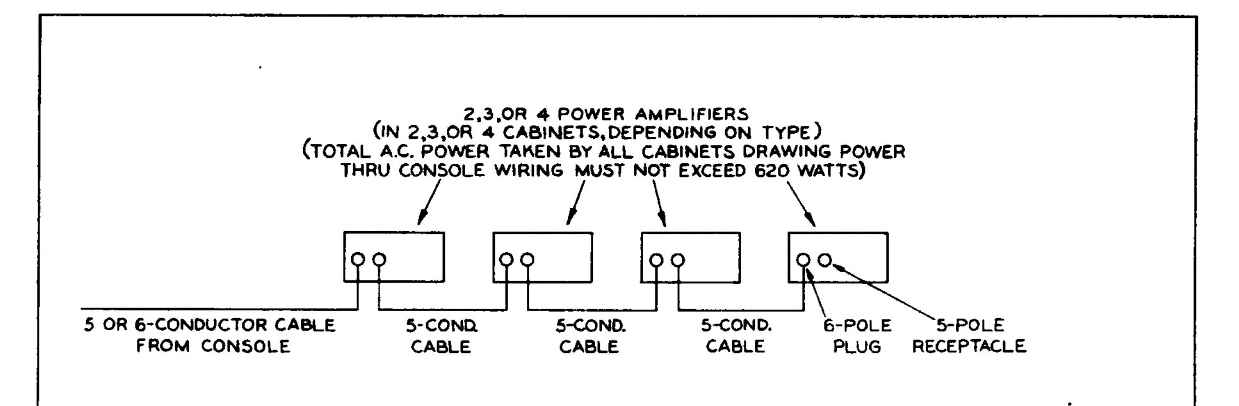


FIGURE 6. DETAILS OF CONNECTION TO TWO OR MORE TONE CABINETS WITH TOTAL OF NOT OVER 620 WATTS A.C. INPUT

(FOR CONNECTIONS OF CABLES TO PLUGS AND RECEPTACLES, SEE FIG. 10)

FIRST CABINET OR CABINETS, TOTALING
NOT OVER 620 WATTS A.C. INPUT,
CONNECTED DIRECTLY TO CONSOLE

A.C. POWER
SOURCE

2 CONDUCTORS
(A.C. POWER TO RELAY COIL)

RELAY
COIL

5-COND.
CABLE

5 OR 6-CONDUCTOR
CABLE FROM CONSOLE

ALL CORDS CONNECTED
IN PARALLEL TO OUTLET

3-CONDUCTOR CABLE
(SIGNAL ONLY)
(5-POLE PLUGS ON
BOTH ENDS)

2-COND. POWER CORDS
(6-POLE RECEPTACLE ONE END;
2-POLE ATTACHMENT PLUG
ON OTHER)

5-POLE
RECEPTACLE

3-COND.
(SIGNAL ONLY)

3-COND.
(SIGNAL ONLY)

5-COND.

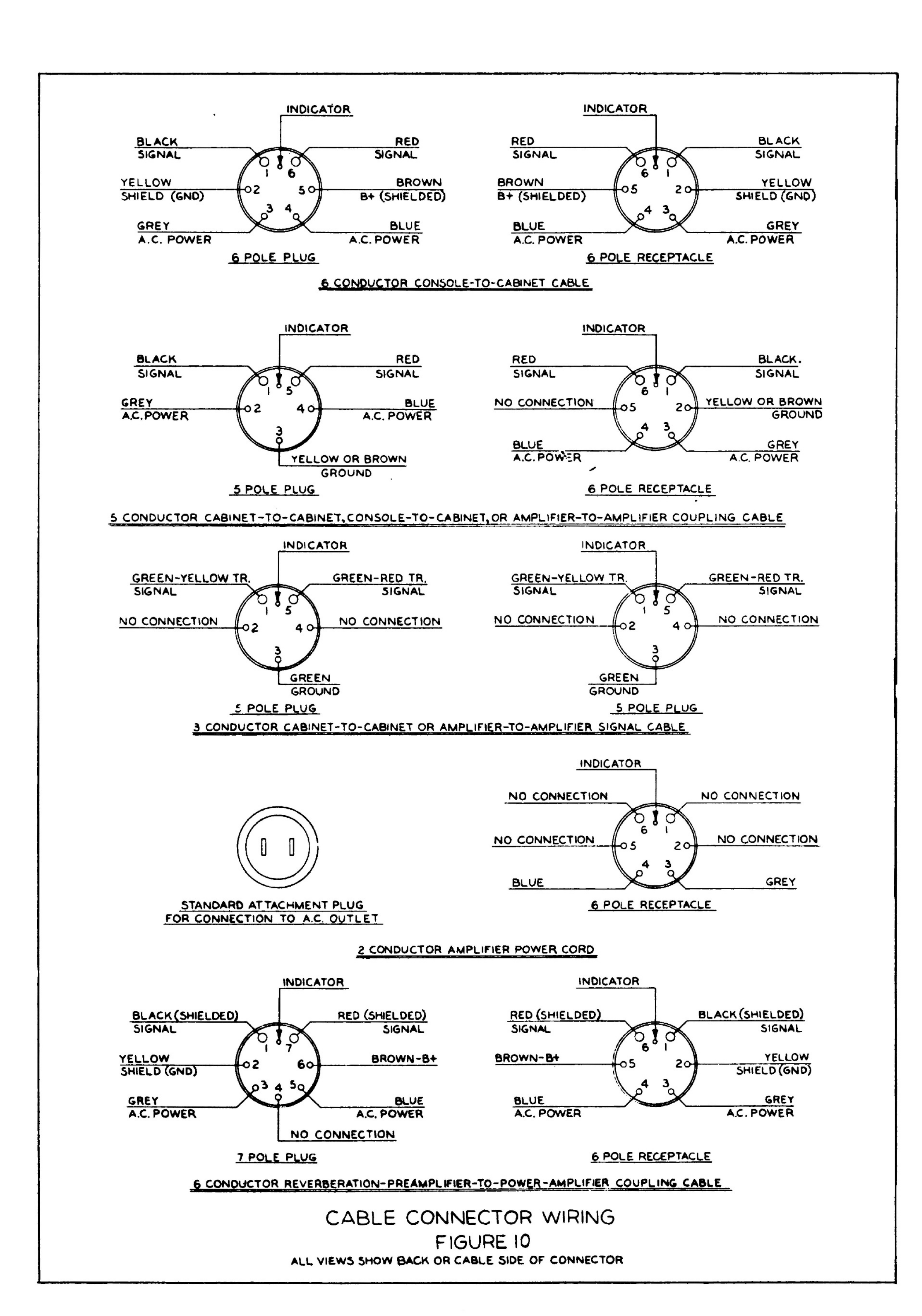
5-COND.

6-POLE PLUG

ANY NUMBER OF ADDITIONAL TONE CABINETS

FIGURE 7. DETAILS OF TYPICAL INSTALLATION OF TONE CABINETS WITH A.C. INPUT TOTALING MORE THAN 620 WATTS

(FOR CONNECTIONS OF CABLES TO PLUGS AND RECEPTACLES, SEE FIGURE 10)



CABLE CONNECTOR WIRING
FIGURE 10
ALL VIEWS SHOW BACK OR CABLE SIDE OF CONNECTOR

EXTENDING SPEAKERS.

When using one or more 20-watt kits in an installation it is sometimes necessary, because of lack of space or for convenience in future servicing, to place the amplifiers some distance from the speakers. Should this become necessary, the leads to the speakers can be consolidated in four conductors. Figure 11 shows how this is accomplished, using the two male plugs on the speakers. In this arrangement the stud connections are not necessary.

The conductors used for this extension must have insulation to withstand 300 volts and wire size should not be less than # 14. Ordinary # 14 house wiring wire, with rubber or plastic insulation, is suitable.

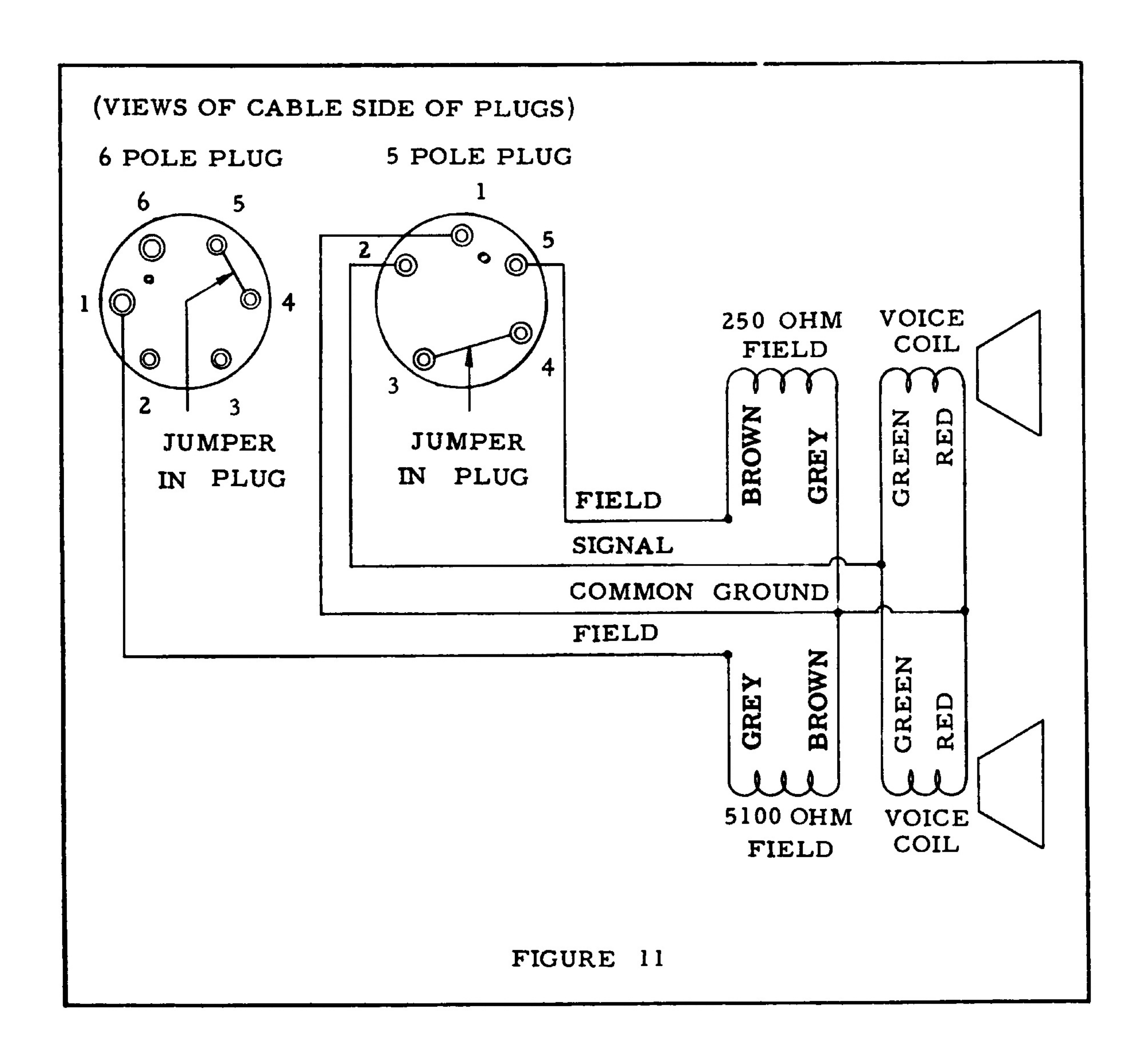
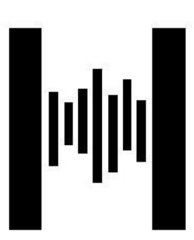


FIGURE 11

THE HAMMOND ORGAN

– 5 –

MAIN GENERATOR



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

TECHNICAL SECTION

MAIN GENERATOR - GENERAL DESCRIPTION

Each Hammond Organ console has a main generator within it, and in some cases, depending on the model, a chorus generator. This section describes a main generator, illustrated (generically) below.



The main generator assembly consists of the generator proper, a shaded pole induction motor for starting, a non self-starting synchronous motor for driving the unit after it is started, and either a tremulant switch mechanism or a Vibrato Scanner mounted on the synchronous motor. The entire assembly is mounted on two long steel angles which also provide the means of mounting the tone generator in the console. The method of mounting is such as to minimize the transmission of vibration from the tone generator to the console.

A drive shaft, resiliently coupled to the synchronous running motor, extends the entire length of the generator. Twenty-four driving gears, two each of twelve sizes, are mounted on this shaft, and the drive shaft itself is divided into several sections connected by flexible couplings. The starting motor is mounted at the end of this drive shaft, opposite the synchronous motor. Section 7 (Console Power Wiring) describes the starting procedure.

The main generator proper is a long structure in which are mounted 48 rotating assemblies, each consisting of a shaft and two discs known as tone or phonic wheels. These assemblies are coupled resiliently to the drive shaft. Each of the driving gears engages two bakelite gears associated with opposite rotating assemblies (See Figure 2). These bakelite gears rotate freely on the shafts with the tone wheels, and are coupled to their respective assemblies by a pair of coil springs. There are 12 sizes of bakelite gears, corresponding to the 12 sizes of driving gears. Thus 4 of the tone wheel assemblies, each with 2 tone wheels, run at each of 12 speeds.

Each tone wheel is a steel disc about 2 inches in diameter, accurately machined with a definite number of high and low points on its edge (See Figure 3). Each high point on a tone wheel is called a tooth. The number of teeth on each of these tone or phonic wheels, in conjunction with the speed at which the tone wheel is revolving, determines the frequency of the tone generated.

Each driving gear, with its two bakelite gears and four tone wheels, runs in a separate compartment magnetically shielded from the rest by steel plates which divide the generator into a series of bins.

All four tone wheels in any one compartment run at the same speed. The individual tone wheel shafts are mounted in bearings made of a special porous bronze and each of these bearings is connected to the oiling system by a cotton thread from the oil trough. Thus, oil from the trough is carried by capillary action to all bearings, penetrating them and lubricating the actual bearing surface. The drive shaft and both motors are lubricated in a similar manner. It is very important to use the recommended grade of oil regularly, as it is essential to the proper operation of the organ that the generator be well lubricated. If oil of varying grades is used, it is likely that the generator may be sluggish in starting, and in time the threads may gum up and prevent the proper flow of oil.

The two spring couplings on the motor shaft, the flexible couplings between sections of the drive shaft, and the tone wheel spring couplings all contribute to absorbing variations in motor speed. The synchronous motor does not deliver absolutely steady power. but rather operates with a series of pulsations, one with each half cycle. If the tone wheels were rigidly coupled to the motor, this slight irregularity would carry extra frequencies into each tone wheel. In addition, hunting is suppressed by the resilient couplings and inertia members of the synchronous motor proper.

Associated with each tone wheel is a magnetized rod about 1/4 of an inch in diameter and 4 inches in length, with a coil of wire wound near one end (See figure 3). The tip of the magnet at the coil end is ground to a sharp edge and mounted near the edge of the tone wheel. Each time a tooth passes this rod it causes a change in the magnetic field which induces a small voltage in the coil. the frequency being determined by the number of teeth and the wheel speed.

Small coils are used on the higher frequency magnets and larger coils on the lower frequencies. It is found that large pole pieces are needed on the low frequency magnets to give good frequency output. but it is necessary to use smaller ones on the high frequencies to prevent excessive iron losses.

Some of the coils have copper rings mounted on them for the purpose of reducing harmonics. As these are used only on fairly low frequency coils, the eddy current loss in such a ring is small for the fundamental frequency of that coil, but high for its harmonics. This has the effect of reducing the relative intensities of any harmonics which may be produced by irregularities in the tone wheels. The wheels are cut so to give as nearly a sine wave as possible, but the generated voltage seldom reaches that ideal condition, since even a change in the air gap will change the wave form. The tip of each magnet, as well as the edge of each tone wheel, is coated with lacquer to prevent corrosion. For, should oxidation set in, the change in tooth shape would introduce irregular frequencies.

Locations of the various magnet and coil assemblies are shown in figure 4. They are identified by their frequency numbers, and the broken line between any two numbers indicates that these two frequencies are supplied by one tone wheel assembly.

Each magnet is set at the factory with the set screw partially loosened, while observing an output meter. Experience has shown that the magnets seldom need adjustment and that setting them without proper equipment involves danger of damaging both magnet and wheel. Therefore it is not recommended that the service man attempt this adjustment.

As a means of eliminating any vagrant harmonics that may be present, there are filters consisting of small transformers and condensers associated with certain frequencies. The transformers have a single tapped winding, and this tap is grounded, so one side, which is connected to the corresponding magnet coil through a condenser, forms a resonant circuit for the fundamental frequency of that coil. This tends to emphasize the fundamental and suppress harmonics.

Locations of these transformers are shown in figures 5 and 6.

These transformers and condensers are mounted on the top of the generator assembly. The transformers are mounted at an angle. thus minimizing interference between them. The cores of the transformers are made of a special iron. and the number of laminations used is adjusted to secure the proper inductance. Wires from the magnet coils connect to the transformers. and wires from the transformers lead to the terminal strip on the generator.

This terminal strip carries the output frequencies of the generator, which are arbitrarily numbered from 1 to 91 in order of increasing frequency. This frequency numbering is continued throughout the instrument. In some models the frequencies are not in order on the terminal strip. and figures 5 and 6 indicate the arrangement for different models. Several terminals at the right end are grounded to the generator frame and serve to ground the manuals and pedals.

Transformers and condensers are not used below frequency 44, but a length of resistance wire shunts each generator. Frequencies 44 to 48 have transformers only, while both transformers and condensers are used for frequencies 49 to 91 except in the case of Model A consoles numbered below 2179, which do not have condensers for frequencies 49 to 54 inclusive. Two condenser values are used: 0.255 mfd for frequencies 49 to 54, and 0.105 mfd for frequencies 55 to 91. The transformers are all different. Each transformer is matched to its condenser and any replacements are supplied as matched pairs by the factory.

There are several types of generators in use and the following information will aid the service technician in identifying the console on which work is being performed.

91 Frequency Generator:

Model A serial No. 1 - 2676
Model B serial No. 4000 - 10549
Model C serial No. 1 - 1247
Model D serial No. 1 - 3143
Model E serial No. 8000 - 8663

The number of tone wheels on the above models is 91, and 5 blank wheels are used to maintain the balance of the rotating units. There are twelve wheels with two teeth, one to operate at each of twelve speeds, and similarly twelve have four teeth, twelve have eight teeth, twelve have sixteen, twelve have thirty-two, twelve have sixty-four, twelve have one hundred and twenty-eight and seven have one hundred ninety-two. An assembly with a two-tooth wheel also has a thirty-two tooth wheel which generates a frequency four octaves above the other. The four and sixty-four tooth wheels go together. as do the eight and one hundred twenty-eight tooth wheels. The twelve sixteen tooth wheels are mounted with seven one hundred ninety-two tooth wheels and the five blank wheels. In this last group the high frequency is not four octaves above, but is four octaves less five semi-tones above the lower.

This arrangement gives a total of 91 frequencies that are connected to corresponding terminals on the generator. and then to the manuals and pedal switch. In all cases. as mentioned above. the generator must be used with corresponding manuals and pedal switches and other types of generators cannot be substituted.

82 Frequency Generator:

Model A serial No. 2677 - 2711
Model B serial No. 10,550 - 17,074
Model C serial No. 1248 - 17,074
Model D serial No. 3144 - 17,074
Model E serial No. 8664 - 8739
Model G serial No. 4101 - 7349

In the above consoles. frequencies # 1 to 9 have been omitted from the generator, and only 82 generator terminals are used. Similarly, there are only 82 tone wheels and magnets in the generator instead of 91. Blank wheels replace the nine two-tooth tone wheels formerly used to produce frequencies 1 to 9.

This generator change accompanies a wiring revision in the manual and pedal switches which makes the frequencies from 1 to 9 unnecessary. Generators having but 82 frequencies are easily identified by a blank space on the terminal strip at the left of the ground terminals. The first terminal at the left of this space is terminal # 10.

91 Frequency Generator with Complex Tone Wheels:

Model BV serial No. 17075 - 29737
Model CV serial No. 17075 - 30287
Model R T serial No. 1001 - 1201
Model B-2 serial No. 35000 - 40303
Model C-2 serial No. 35001 - 40459
Model RT-2 serial No. 1300 - 2150

In these consoles, the original two-tooth wheels in the generator have been replaced with twelve two-tooth complex tone wheels, which supply a fundamental tone. that is enriched with the odd-number harmonics. Both manuals and pedal switch are wired differently and are therefore not interchangeable with earlier models.

91 Frequency Generator with Complex Tone Wheels and narrow cover:

Models B-2, C-2, RT-2 (Except those listed in prior paragraph) and all B-3, C-3, RT-3, A-100, and D-100.

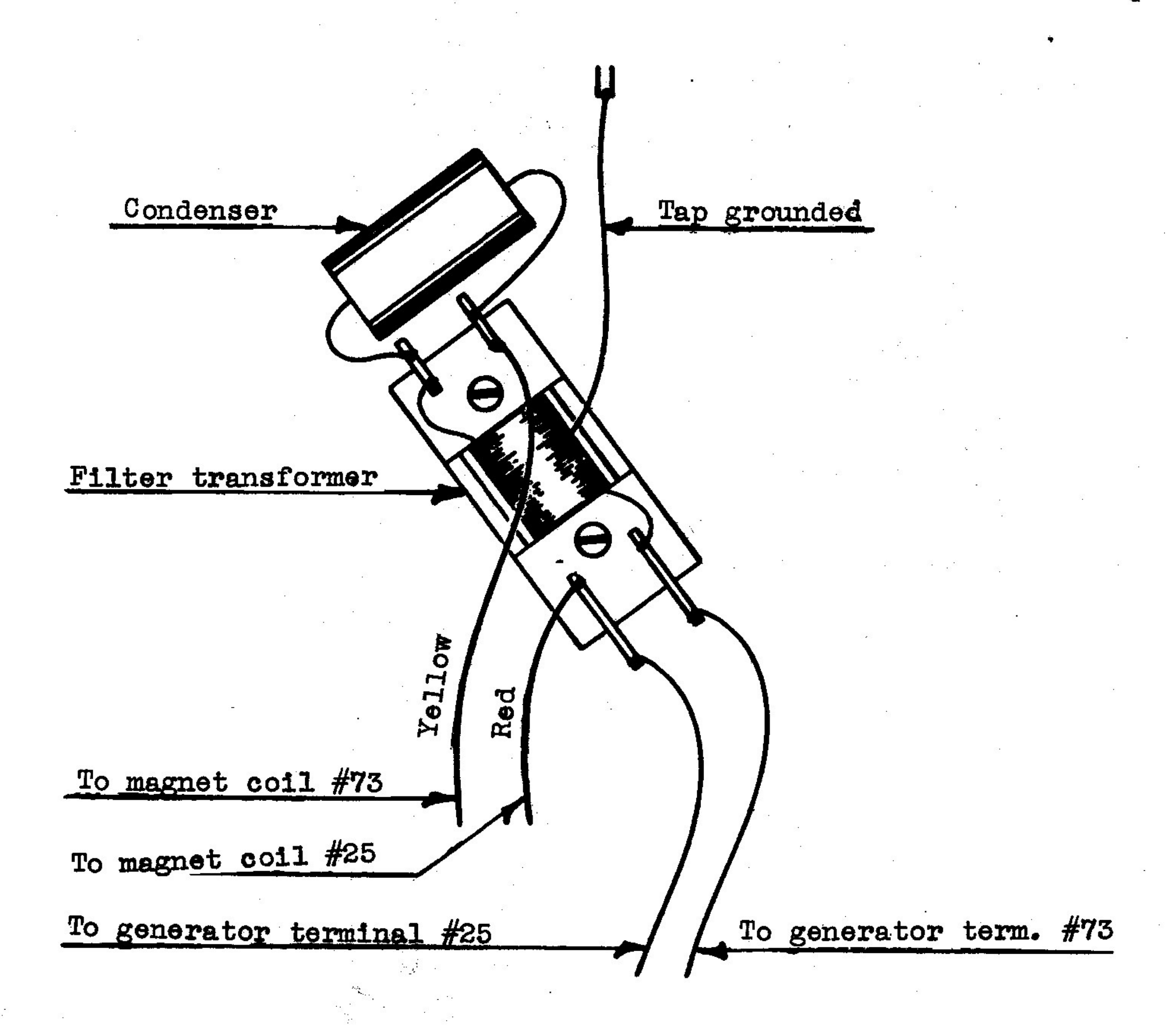
This generator has twelve complex tone wheels and is identical to the one above except for the generator cover. Because the output terminals of this cover are not in order of frequency (See figure 6) this type of generator is not interchangeable with the one above.

Note: Consoles have been made equipped with 115 volt 25 or 50 or 60 cycle and 230 volt 50 or 60 cycle generators. If the owner is contemplating moving to a location having a different frequency of current, the complete generator must be changed. Where voltage changes only are encountered, step-up or step-down transformers will be necessary.

Generator Anchoring

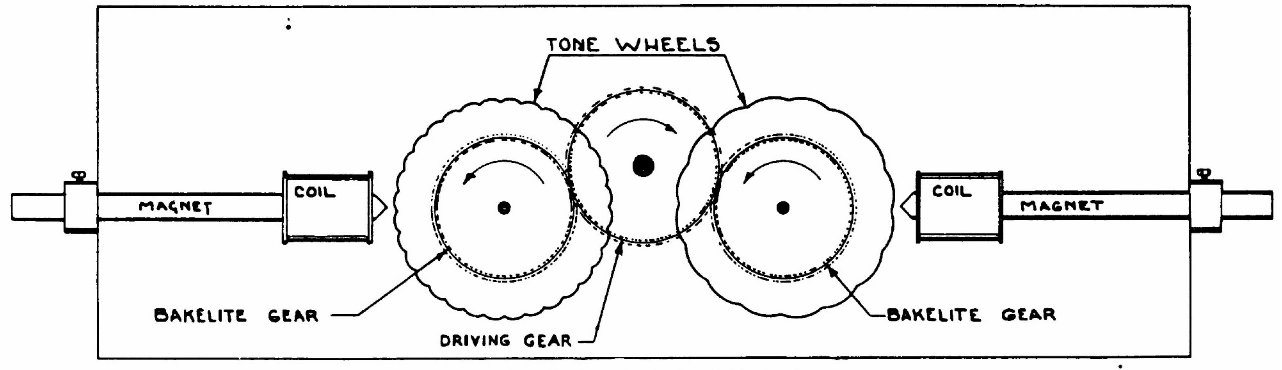
When a console is set up for operation the anchoring must be loosened so that the generator will float freely on its spring suspension system. No damage will result if this is not done, but the console will sound noisy, and the same is true if the anchoring is loosened but the console is not level. If the console is to be moved a long distance the anchoring should be tightened during such moves.

Several different types of anchoring have been employed and instructions for loosening and tightening the generator in any particular console are given on the instruction card contained in the bench which accompanied that console.

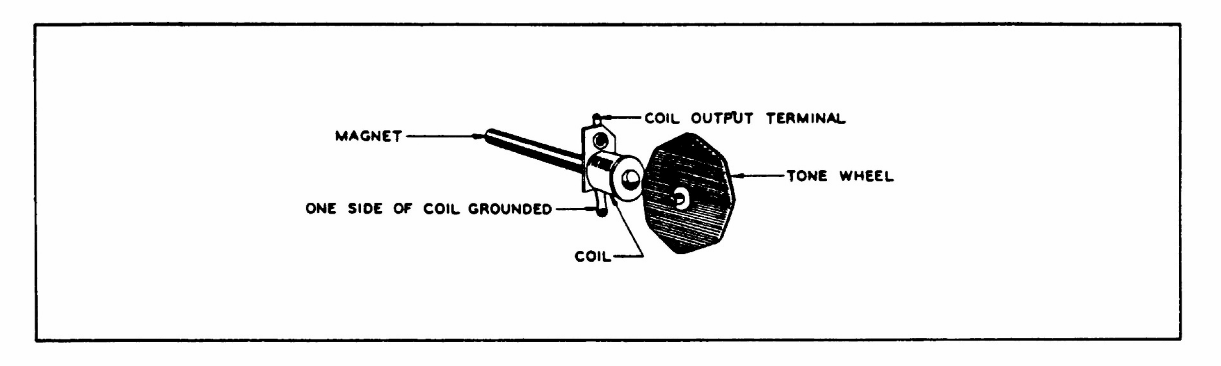


TYPICAL FILTER CONNECTIONS

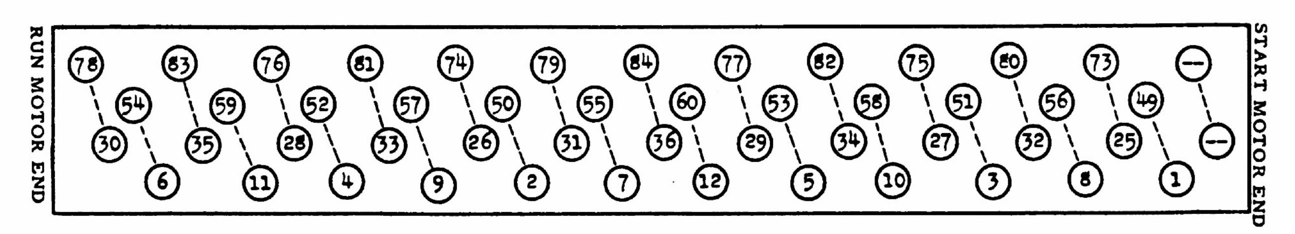
Figure 1



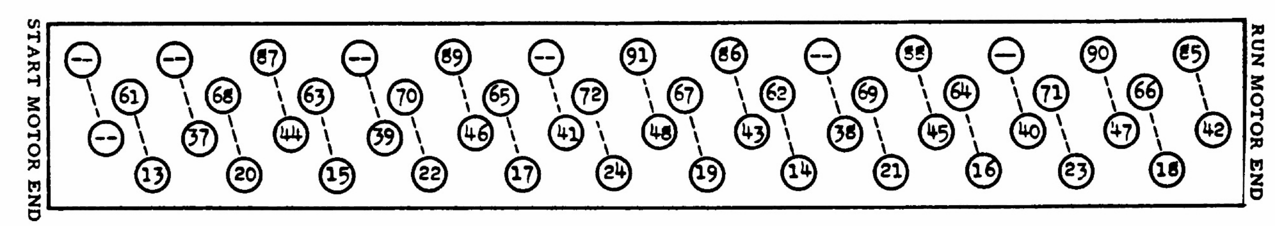
SECTION OF MAIN GENERATOR
Figure 2.



TONE GENERATOR
Figure 3.



BACK VIEW OF MAIN GENERATOR



FRONT VIEW OF MAIN GENERATOR

GENERATOR MAGNET LOCATIONS

Figure 4.

(Numbers shown are frequency numbers)

NUMBERS ON FILTER TRANSFORMERS ARE FREQUENCY NUMBERS OF TRANSFORMERS

SYNCHRONOUS MOTOR END

STARTING MOTOR END

FILTER TRANSFORMERS

FILTER CONDENSERS

85 66 90 71 47 64 88 69 45 62 86 67 91 72 48 65 89 70 46 63 87 68 44 61

78 54 83 59 76 52 81 57 74 50 79 55 84 60 77 53 82 58 75 51 80 56 73 49

91 75 50 25 1

OUTPUT TERMINAL FREQUENCY NUMBERS IN CONSECUTIVE ORDER

FIGURE 5 - MAIN GENERATOR COVER

MODELS A, B, BC, BV, C, CV, D, DV, E, AND RT
MODEL B-2 SERIAL NUMBERS BELOW 40304
MODEL C-2 SERIAL NUMBERS BELOW 40460
MODEL RT-2 SERIAL NUMBERS BELOW 2151

NUMBERS ON FILTER TRANSFORMERS ARE FREQUENCY NUMBERS OF TRANSFORMERS

SYNCHRONOUS MOTOR END

FILTER TRANSFORMERS

SOME GENERATORS HAVE FILTER CONDENSERS MOUNTED ON TOP OF TRANSFORMERS

STARTING MOTOR END

FILTER CONDENSERS

85 66 90 71 47 64 88 69 45 62 86 67 91 72 48 65 89 70 46 63 87 68 44 61

78 54 83 59 76 52 81 57 74 50 79 55 84 60 77 53 82 58 75 51 80 56 73 49

42 78 18 54 35 71 11 47 28 64 4 88 81 21 57 38 74 14 50 43 79 19 55 36 72 12 48 29 65 5 89 82 22 58 39 75 15 51 32 68 8 44 25 61 1

85 30 66 6 90 83 23 59 40 76 16 52 33 69 9 45 26 62 2 86 31 67 7 91 84 24 60 41 77 17 53 34 70 10 46 27 63 3 87 80 20 56 37 73 13 49

OUTPUT TERMINAL FREQUENCY NUMBERS

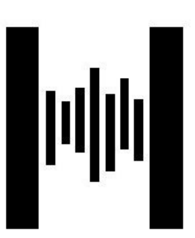
FIGURE 6 - MAIN GENERATOR COVER

MODEL B-2 SERIAL NUMBER 40304 AND ABOVE
MODEL C-2 SERIAL NUMBER 40460 AND ABOVE
MODEL RT-2 SERIAL NUMBER 2151 AND ABOVE
ALL B-3 C-3 AND RT-3 CONSOLES

THE HAMMOND ORGAN

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CHORUS GENERATOR



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Copenhagen Court - Franklin Park
Illinois
USA

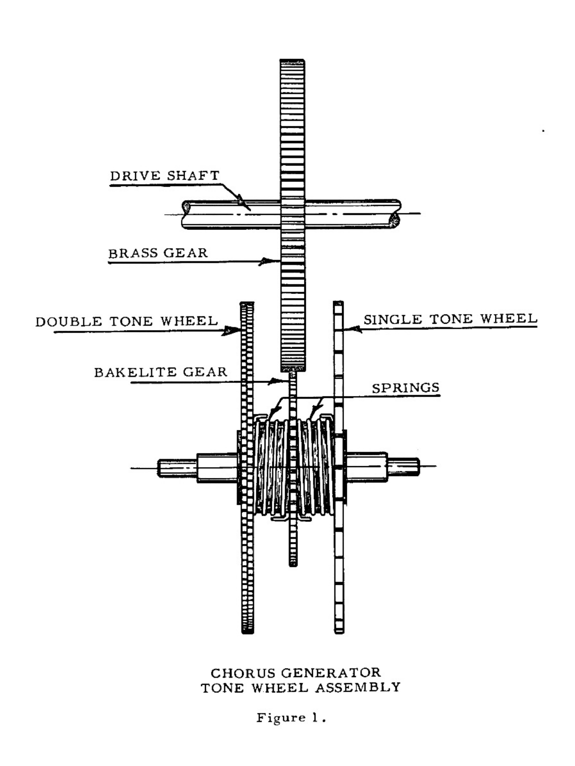
CHORUS GENERATOR
(Used in Models BC, D, E, and G)

The purpose of the chorus generator is to add a series of slightly sharp and slightly flat tones to the true tones produced by the main generator. The resulting electrical wave contains a complex series of undulations which enhance the pleasing effect of many tone qualities, notably string and full organ combinations. It should be noted that no chorus effect is produced on frequencies below 56.

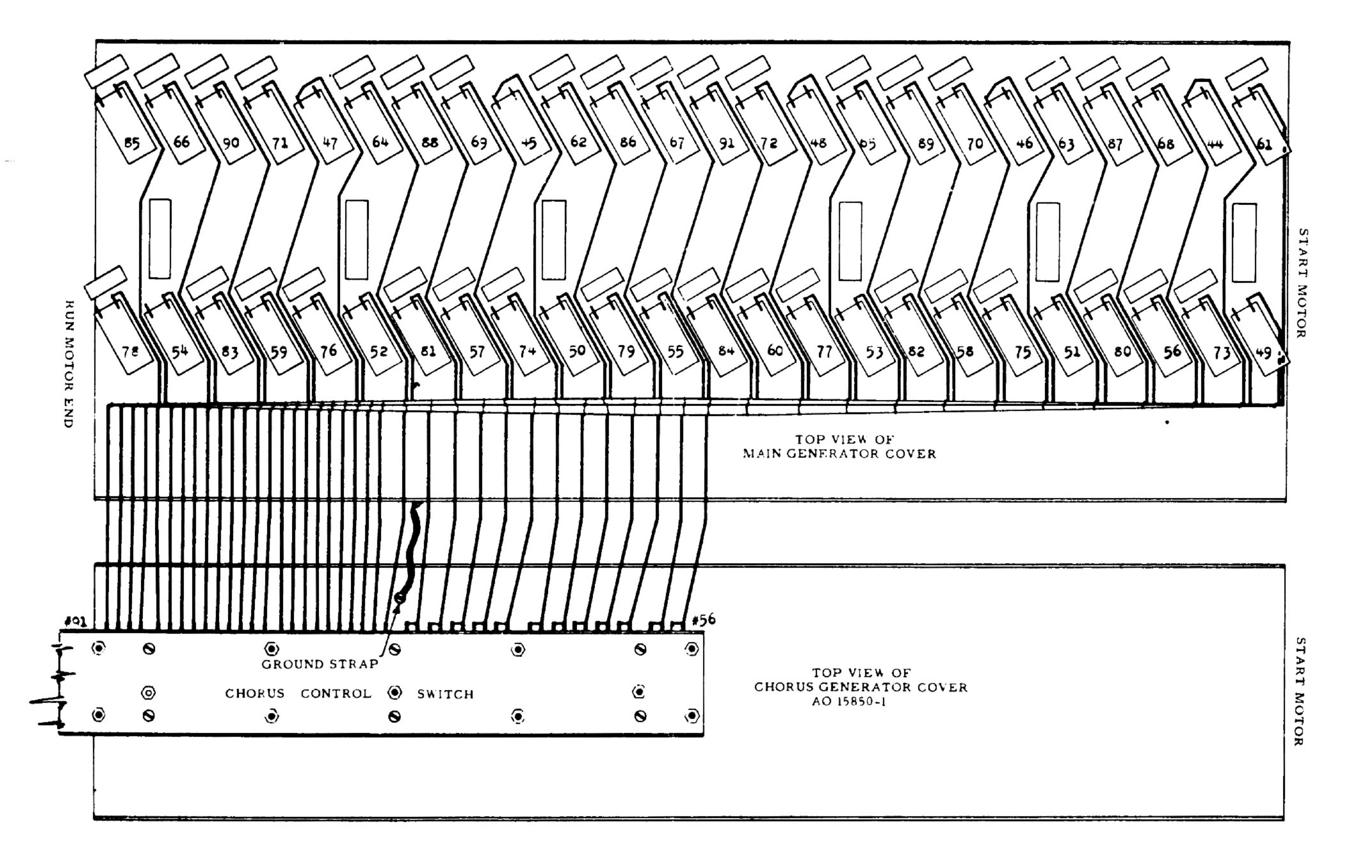
The frequencies covered by the chorus generator are numbers 56 to 91 inclusive on the main generator. The difference in frequency between the main generator and either flat or sharp tone is 0.8% for frequencies 56 to 67 and 0.4% for frequencies 68 to 91. It is necessary that a lesser percentage of frequency difference be present in the higher register in order to avoid too rapid undulation.

The chorus generator assembly, like the main generator, has a drive shaft with twenty-four brass gears. Each gear drives a single assembly consisting of two tone wheels. The drive gears vary as to the number of teeth, and the tone wheels operate at twenty-four different speeds. This generator has forty-eight tone wheels, each with a separate magnet and pick-up coil. Of these tone wheels, twenty-four are single and twenty-four are double (see figure 1). The double tone wheels consist of two discs with different numbers of teeth mounted on one brass hub. The single wheels are electrically connected in pairs, each pair being so connected as to have the same effect as one double wheel.

Figure 2 is a complete wiring diagram for connections between main and chorus generators, and figure 3 is a back view of the chorus generator indicating the frequency number of each magnet.



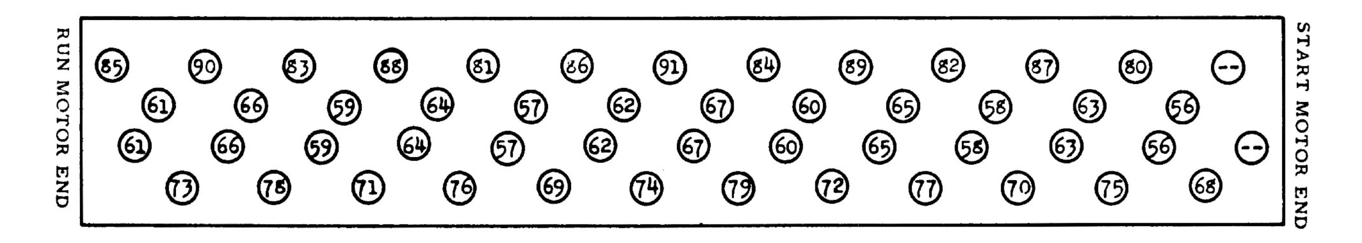
CHORUS GENERATOR
TONE WHEEL ASSEMBLY
Figure 1.



NOTE: NUMBERS SHOWN ON FILTER TRANSFORMERS ARE FREQUENCY NUMBERS.

CABLE CONNECTIONS TO CHORUS GENERATOR

Figure 2.



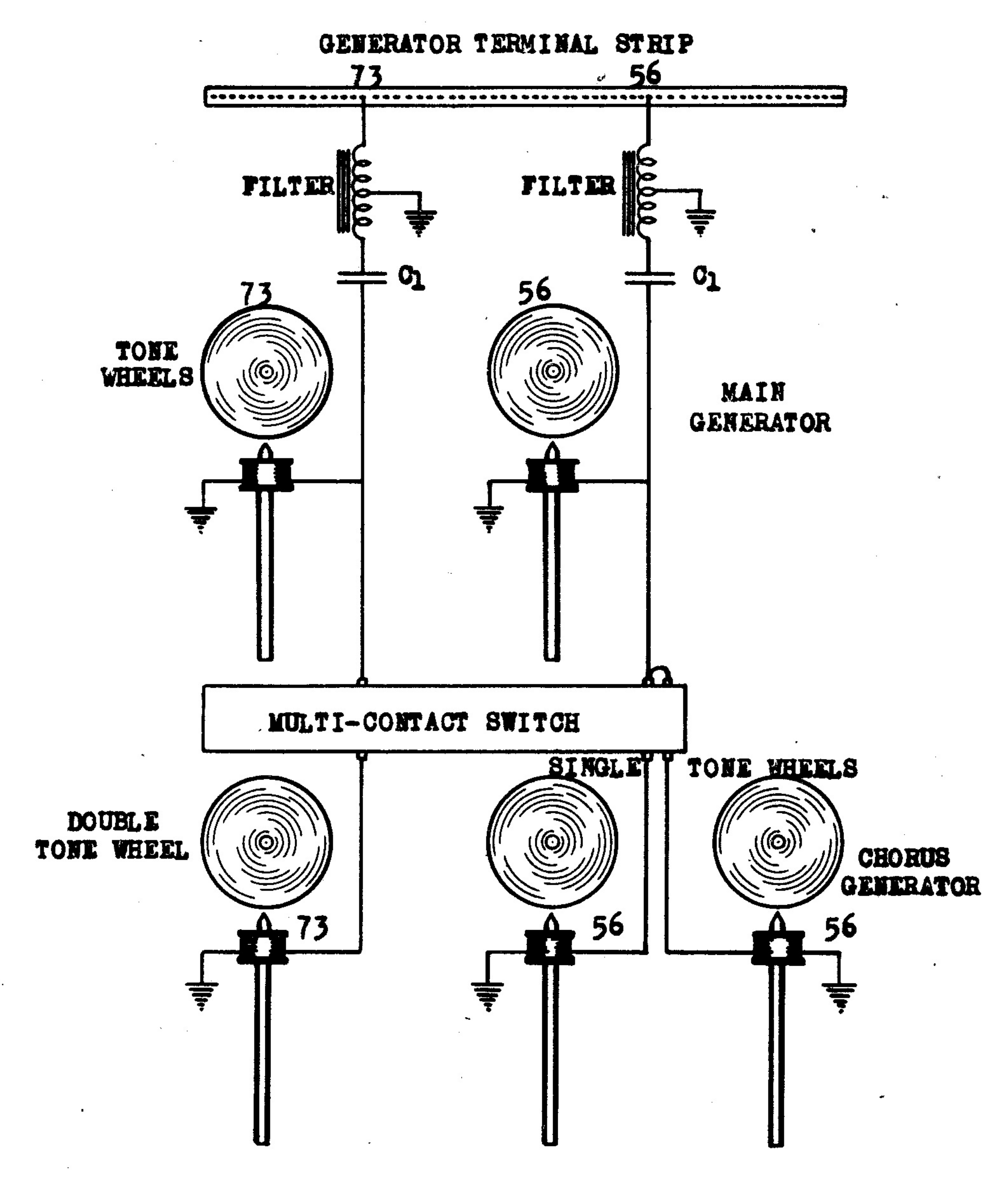
BACK VIEW OF CHORUS GENERATOR

(NUMBERS SHOWN ARE FREQUENCY NUMBERS)

CHORUS GENERATOR MAGNET LOCATIONS

Figure 3

Figure 5 (there is no figure 4 - JL) below shows the signal flow between both Main and Chorus Generator:



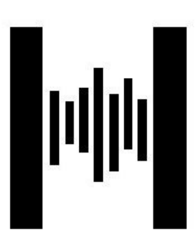
CHORUS GENERATOR WIRING

FIGURE 5.

THE HAMMOND ORGAN

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CONSOLE POWER WIRING



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USA

CONSOLE POWER WIRING
(Main and Chorus Generators)

Starting and Synchronous Motors

A shaded pole induction motor is used for starting the generator and is located at the right end of the generator as viewed from the back. The rotor of this motor will slide endwise when current is supplied and engage a pinion on its shaft with a gear on the generator driving shaft, bringing the tone generator up to slightly greater than synchronous speed.

When the organ is started, the starting switch is turned on and held for about 8 seconds while the starting motor brings the system up to speed. The run switch is then turned on. This switch simultaneously connects the synchronous motor and introduces a resistor in series with the starting motor (figure 1), thus reducing its driving power. With a braking action of the synchronous motor and a loss of power of the starting motor, the system slows to synchronous speed and the synchronous motor begins to carry the load. A period of about 8 seconds should be allowed for this to take place, after which the starting switch may be released. The starting switch springs back to the off position, and turns off the starting motor, which is disengaged from the rotating shaft by a spring.

It should be noted that the synchronous motor can supply power only at synchronous speed. Therefore, if for any reason the system fails to reach synchronous speed it will not continue to run after the starting switch is released. Failure to start properly is usually due to increased oil viscosity and may be overcome by an increase in starting time.

As the schematic diagram (figure 1) indicates, the run switch in its off position shorts out the wirewound resistor attached to the line panel. If the run switch is defective in its off position, the generator will not start because this resistor will be permanently in series with the starting motor. Before assuming that there is anything amiss with the motors, short out this resistor and start the generator in the normal manner. If the generator operates satisfactorily, replace the run switch.

The run switch on all consoles is a two-circuit switch. but types of switches having two different terminal arrangements have been used, as shown in figure 2. When replacing a switch, observe the wiring of the old switch and check the connections of the new switch with an ohmmeter. Note that black and blue are connected in the on position. and yellow and brown are connected in the off position, no matter which type of switch is used.

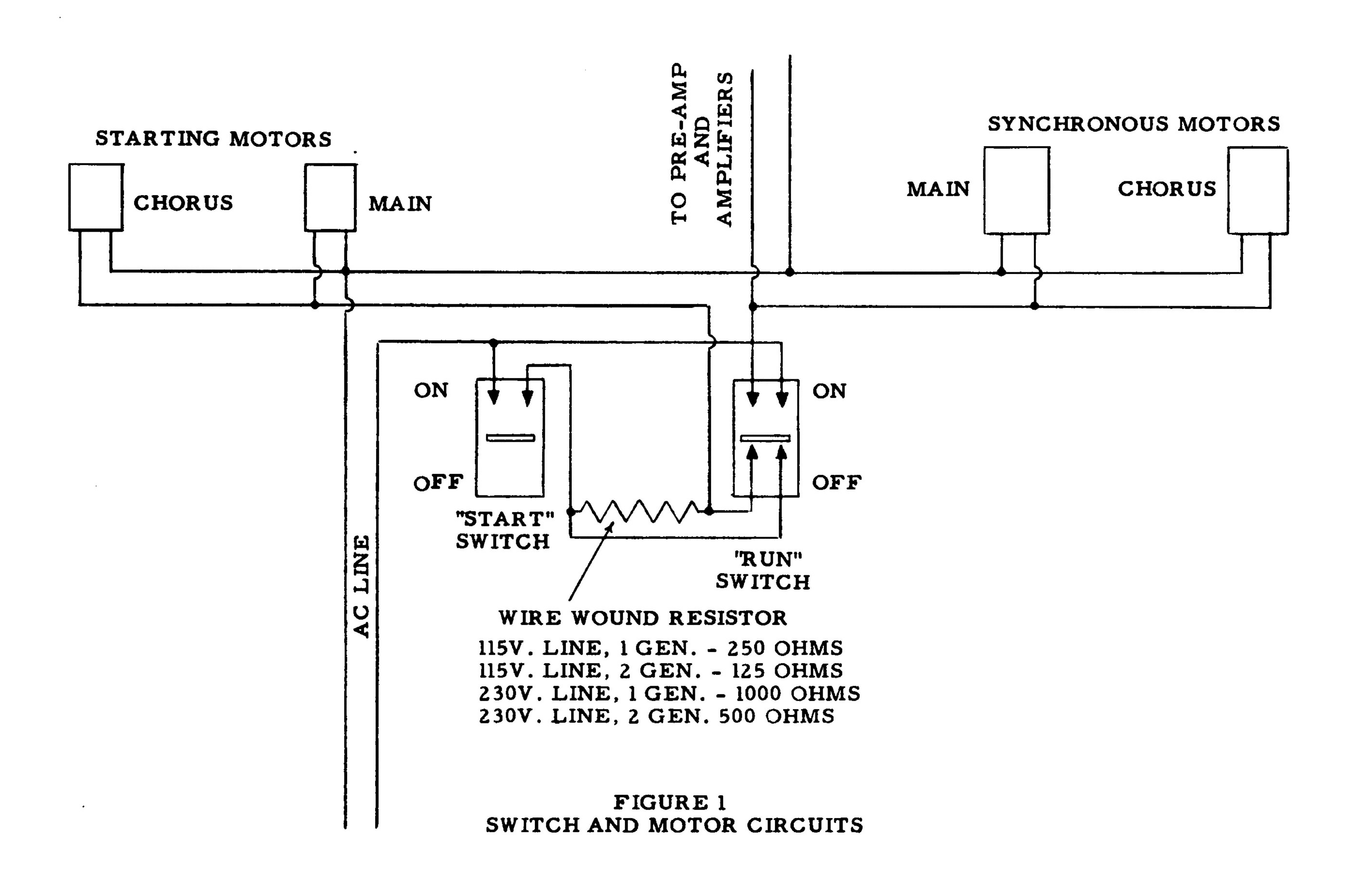


FIGURE 1
SWITCH AND MOTOR CIRCUITS

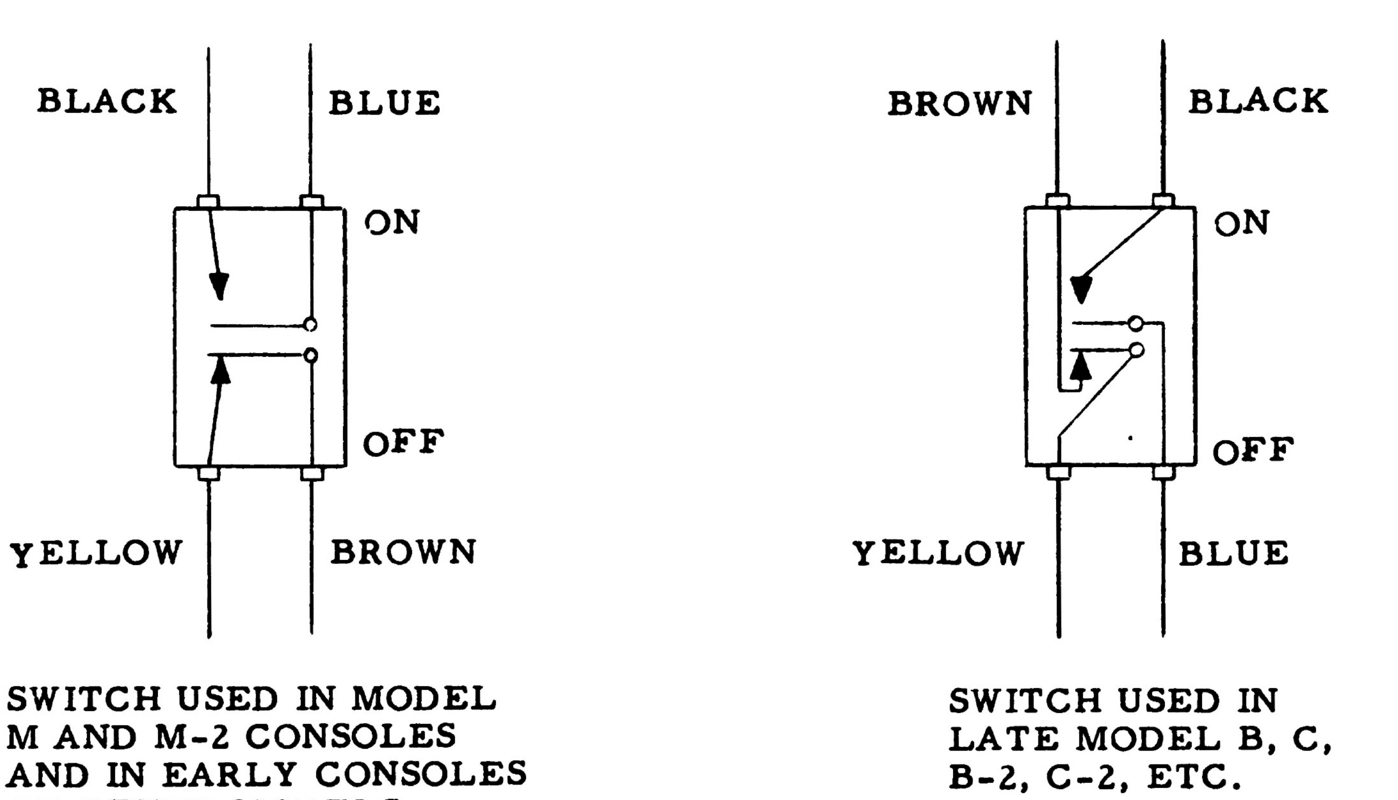


FIG 2
TWO TYPES OF "RUN" SWITCHES

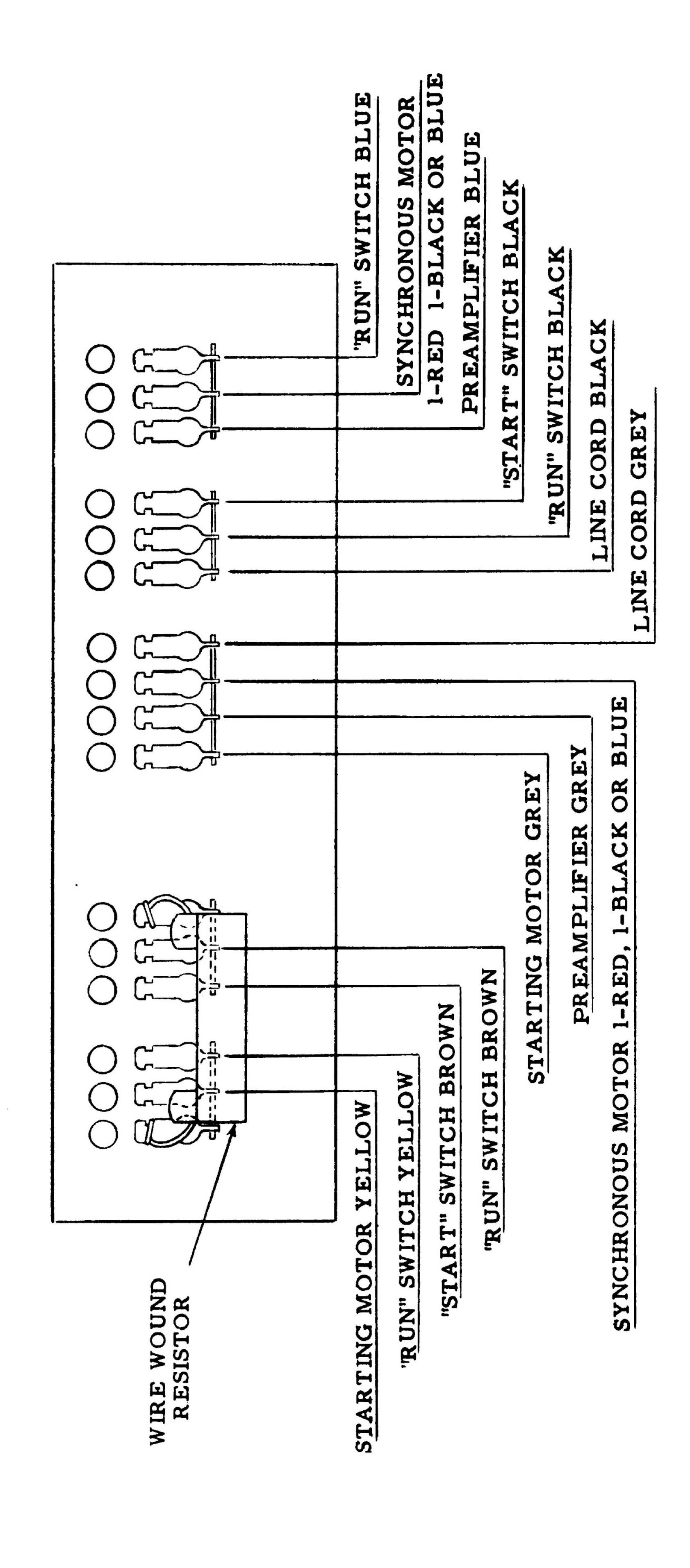


FIG. 3

LINE PANEL (EARLY CONSOLES)

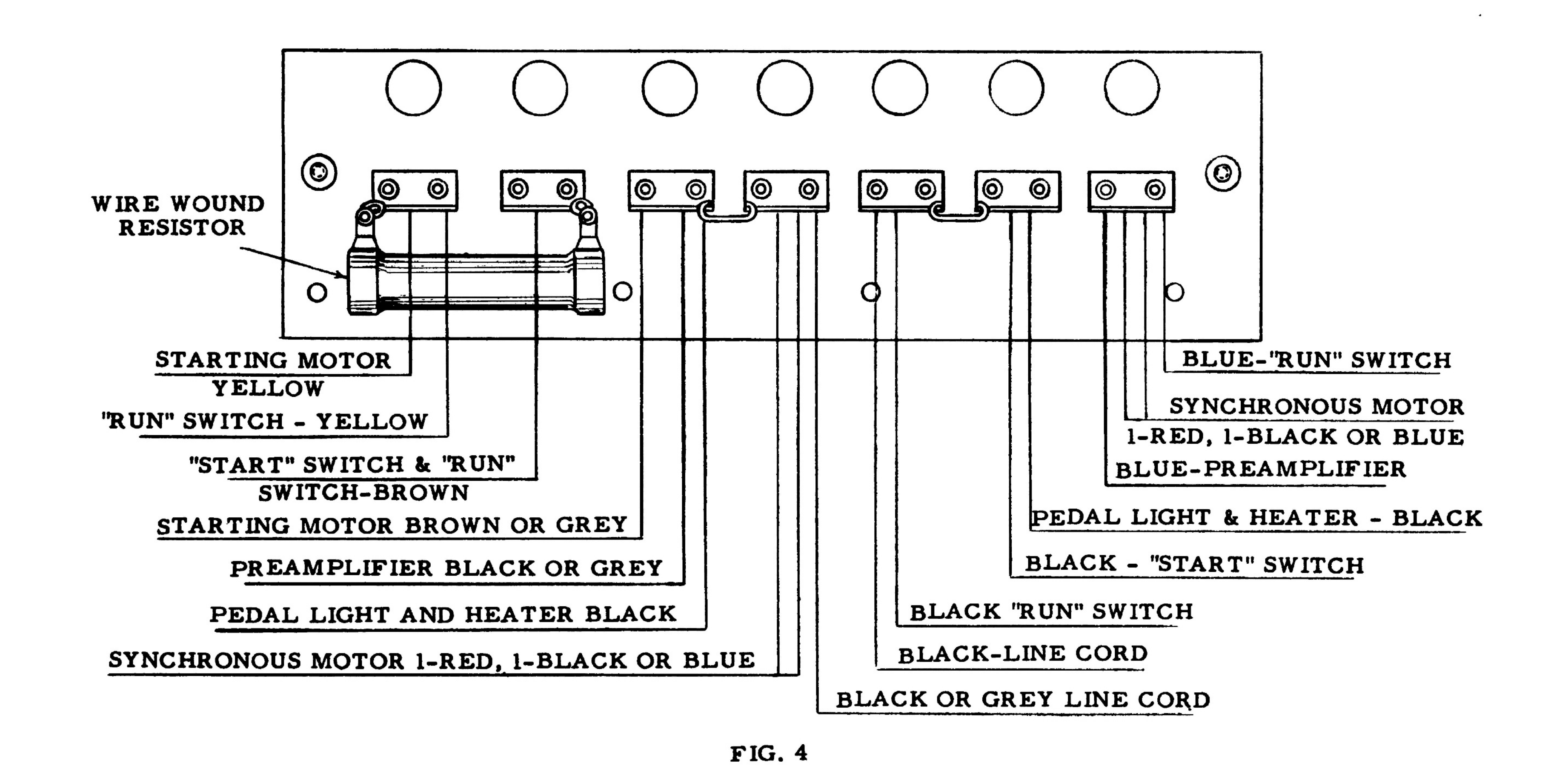


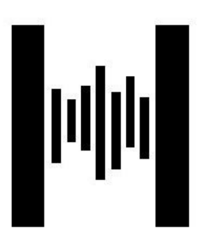
FIG. 4

LINE PANEL (LATER CONSOLES)

THE HAMMOND ORGAN

– 8 –

MANUALS, PEDALS,
MATCHING TRANSFORMERS
and
PRESET PANEL



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Illinois
USA



Figure 1: Typical Console Manual (B2)
For a description of controls - see Section 2

Manual Chassis Assembly - Models A, AB, AV, BC, BCV, BV, C, CV, D, DV, G, GV, RT.

The manual chassis assembly, figure 1, which includes the upper and lower manuals and the preset panel, has a terminal strip under each manual made up of 82 or 91 terminals, depending on the generator being used, to accommodate the frequencies from the tone generator assembly. Each manual has 61 playing keys, 9 preset keys, and 2 adjust keys, each of which operates nine small bronze contact springs with precious metal points (See figure 2). When a key is pressed these points make contact with nine busbars extending the entire length of the manual. The busbars also have precious metal contact surfaces.

The nine contact springs under each key carry the nine harmonics of the particular note with which they are associated (See figure 3) and are connected by resistance wires to the proper terminals on the terminal strip. Therefore all key contacts are alive whenever the generator is running. See schematic diagram of console in the Diagrams & Schematics section.

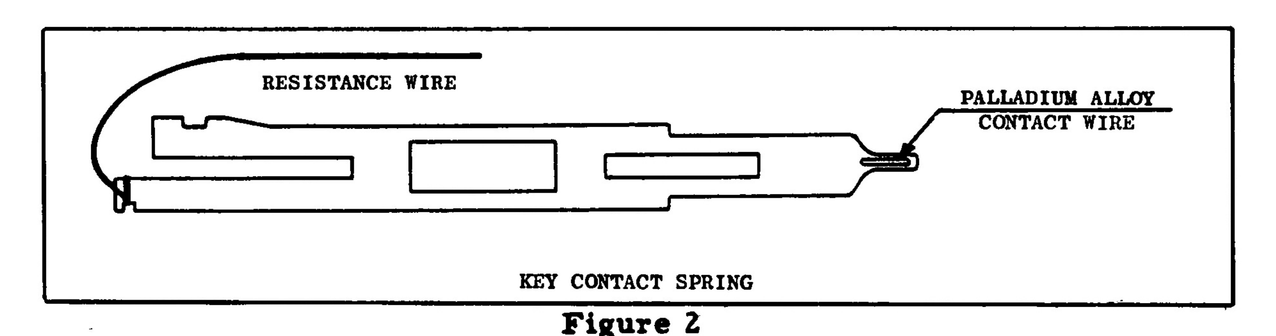


Figure 2

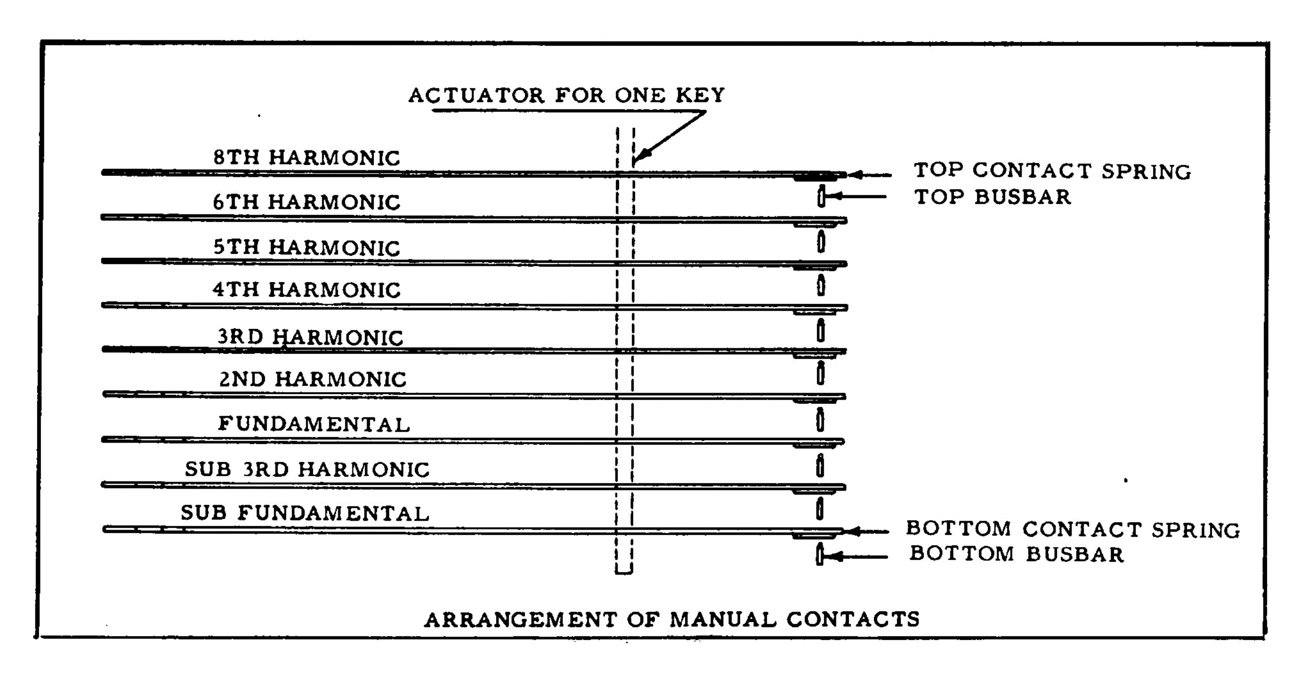


Figure 3

When a playing key is pressed, its nine frequencies are impressed on the nine busbars of the manual. As there are no wires connected to these busbars, a preset or adjust key must be depressed before any circuit can be completed. Each preset and adjust key has nine contacts exactly like those of the playing keys. These keys have a locking and trip mechanism which allows only one key to be in operation at one time. The key at the extreme left end of the manual is a cancel key, with no contacts, which releases any preset or adjust key that happens to be depressed.

The adjust keys, A# and B, are connected by flexible wires, color-coded for easy identification, to the corresponding nine drawbars. The drawbars slide over nine busses which are connected to taps on the matching transformer. These correspond to different intensities of sound as shown by numbers on the drawbars.

The two left groups of drawbars are associated with the upper manual, while the two right groups work in conjunction with the lower manual. In each case the A# adjust key controls the left hand group of drawbars for that manual. The nine preset keys, from C# to A inclusive, are wired to flexible leads terminating at the preset panel in the back of the console, where the various tone colors are set up by connecting each wire to a screw terminal corresponding to the desired intensity of the harmonic. These screw terminals are located on 9 horizontal bars, each representing a certain intensity for all wires attached to that bar.

The drawbar busses and the preset panel bars are connected in parallel to taps on the primary of the matching transformer.

Manual Chassis Assembly - Models B-2, C-2 and RT-2

In these selective vibrato consoles, the individual manuals are the same as in other models but the drawbar assembly is different, having three tilting tablets (Vibrato Swell On-Off, Vibrato Great On-Off and Volume Soft-Normal) at the left of the vibrato switch knob.

The selective vibrato feature requires that the preset panel and drawbar assembly be divided and connected to two matching transformers, each serving one manual. See Diagrams & Schematics section. The Great, or lower manual, matching transformer also serves the pedal keyboard.

Continuous-contact drawbars are used in later consoles of this type. They operate more smoothly and require less accuracy of adjustment than the earlier type having nine definite positions or steps. Each one has two contacts connected together by a one ohm resistor, so that at least one of the contacts touches some bus at all times and there are no dead spots in the drawbar motion. The resistor avoids short-circuiting adjacent busbars.

Manual Chassis Assembly - Models B-3, C-3, RT-3, A-100 & D-100

The above description also applies to these models, but the start and run switches are relocated to provide room for four tilting tablets which control the Percussion feature, described in Section 2. All manual chassis assemblies are equipped with continuous contact drawbars.

Manual Chassis Assembly - Model E

The appearance of the upper, or swell manual, and the lower, or great manual, is the same as on other models except that numbered pistons are used instead of preset keys. These pistons operate in exactly the same manner, and produce the same effects, as do the preset keys on the other models.

The internal wiring of the manuals is to a large extent the same as in other models, but the use of two tremulants requires that the preset panel and drawbar assembly be divided, and that two matching transformers be used, each manual being connected to its own matching transformer.

Manual Busbar Shifters

The precious metal contact surfaces of the key contacts and busbars are not subject to corrosion, and the manuals are sealed to exclude dust as far as possible. In spite of these precautions an occasional particle of dust many lodge on a contact and cause the note to be scratchy, noisy, or silent, and for this reason a busbar shifting mechanism is provided on each manual to slide the busbars endwise and thus provide a fresh contact surface. The busbar shifter for each manual is a slotted stud near the right end of the manual as viewed from the back of the console (see rear view of console in Section 2 for location).

If any note becomes scratchy or silent, it should first be struck 15 or 20 times in a rapid staccato manner to loosen the dirt. This will usually dislodge the particles and clear the note.

In case this procedure is not effective, the busbar shifter for that manual may be adjusted by turning the stud about two turns in either direction. It may sometimes be necessary to hold down the offending key while turning the busbar shifter, in order to wipe the contact clean.

Model A consoles below serial number 995 are not equipped with busbar shifters except in cases where the manual chassis and pedal switch have been rebuilt.

Manual Wiring - Models A, AB, AV, BC, BCV, BV, C, CV, D, DV, G, GV, RT.

Figure 4, a wiring chart for the playing manuals, will be helpful in tracing difficulties associated with the generator or manuals. All playing manuals are wired alike from drawbar 2 to drawbar 8 inclusive, but the wiring of drawbars 1 and 9 varies. Column A shows the wiring of drawbar 1 for consoles above serial number 17075; column B refers to all consoles having 82 note generators; and column C is the wiring used in all earlier consoles. Column D shows wiring of drawbar 9 for Model A consoles below serial number 2500 and Model BC console below 5076; column E refers to all later consoles.

These variations in wiring are designed to match the different type of generators described in the section covering tone generators, and therefore the various types are not interchangeable.

Manual Wiring - Models B-2, B-3, C-2, C-3, RT-2, RT-3, A-100 & D-100

The key circuit wiring for these models is the same as for previous consoles above serial number 17075, and so columns A and E in figure 4 apply.

		"A" (See text)	"B"	"C"								"D" (See text)	"E"
Key Number	Note	Drawbar 1 Sub-Fund.	Drawbar 1 Sub-Fund.	Drawbar 1 Sub-Fund.	Drawbar 2 Sub-3rd	Drawbar 3 Fund.	Drawbar 4 2nd Harm.	Drawbar 5 3rd Harm.	Drawbar 6 4th Harm.	Drawbar 7 5th Harm.	Drawbar 8 6th Harm.	Drawbar 9 8th Harm.	Drawbar 9 8th Harm.
1	C	13	13	1	20	13	25	32	37	41	44	49	49
2	C#	14	14	2	21	14	26	33	38	42	45	50	50
3	D	15	15	3	22	15	27	34	39	43	46	51	51
4	D#	16	16	4	23	16	28	35	40	44	47	52	52
5	E	17	17	5	24	17	29	36	41	45	48	53	53
6	F	18	18	6	25	18	30	37	42	46	49	54	54
7	F#	19	19	7	26	19	31	38	43	47	50	55	55
8	G	20	20	8	27	20	32	39	44	48	51	56	56
9	G#	21	21	9	28	21	33	40	45	49	52	57	57
10	A	22	10	10	29	22	34	41	46	50	53	58	58
11	A#	23	11	11	30	23	35	42	47	51	54	59	59
12	B	24	12	12	31	24	36	43	48	52	55	60	60
13	C	13	13	13	32	25	37	44	49	53	56	61	61
14	C#	14	14	14	33	26	38	45	50	54	57	62	62
15	D	15	15	15	34	27	39	46	51	55	58	63	63
16	D#	16	16	16	35	28	40	47	52	56	59	64	64
17	E	17	17	17	36	29	41	48	53	57	60	65	65
18	F	18	18	18	37	30	42	49	54	58	61	66	66
19	F#	19	19	19	38	31	43	50	55	59	62	67	67
20	G	20	20	20	39	32	44	51	56	60	63	68	68
21	G#	21	21	21	40	33	45	52	57	61	64	69	69
22	A	22	22	22	41	34	46	53	58	62	65	70	70
23	A#	23	23	23	42	35	47	54	59	63	66	71	71
24	B	24	24	24	43	36	48	55	60	64	67	72	72
25	C	25	25	25	44	37	49	56	61	65	68	73	73
26	C#	26	26	26	45	38	50	57	62	66	69	74	74
27	D	27	27	27	46	39	51	58	63	67	70	75	75
28	D#	28	28	28	47	40	52	59	64	68	71	76	76
29	E	29	29	29	48	41	53	60	65	69	72	77	77
30	F	30	30	30	49	42	54	61	66	70	73	78	78
31	F#	31	31	31	50	43	55	62	67	71	74	79	79
32	G	32	32	32	51	44	56	63	68	72	75	80	80
33	G#	33	33	33	52	45	57	64	69	73	76	81	81
34	A	34	34	34	53	46	58	65	70	74	77	82	82
35	A#	35	35	35	54	47	59	66	71	75	78	83	83
36	B	36	36	36	55	48	60	67	72	76	79	84	84
37	C	37	37	37	56	49	61	68	73	77	80	85	85
38	C##	38	38	38	57	50	62	69	74	78	81	86	86
39	D	39	39	39	58	51	63	70	75	79	82	87	87
40	D#	40	40	40	59	52	64	71	76	80	83	88	88
41	E	41	41	41	60	53	65	72	77	81	84	89	89
42	F	42	42	42	61	54	66	73	78	82	85	90	90
43	F#	43	43	43	62	55	67	74	79	83	86	91	91
44	G	44	44	44	63	56	68	75	80	84	87	68	80
45	G#	45	45	45	64	57	69	76	81	85	88	69	81
46	A	46	46	46	65	58	70	77	82	86	89	70	82
47	A#	47	47	47	66	59	71	78	83	87	90	71	83
48	B	48	48	48	67	60	72	79	84	88	91	72	84
49	C	49	49	49	68	61	73	80	85	89	80	73	85
50	C#	50	50	50	69	62	74	81	86	90	81	74	86
51	D	51	51	51	70	63	75	82	87	91	82	75	87
52	D#	52	52	52	71	64	76	83	88	80	83	76	88
53	E	53	53	53	72	65	77	84	89	81	84	77	89
54	F	54	54	54	73	66	78	85	90	82	85	78	90
55	F#	55	55	55	74	67	79	86	91	83	86	79	91
56	G	56	56	56	75	68	80	87	80	84	87	80	80
57	G#	57	57	57	76	69	81	88	81	85	88	81	81
58	A	58	58	58	77	70	82	89	82	86	89	82	82
59	A#	59	59	59	78	71	83	90	83	87	90	83	83
60	B	60	60	60	79	72	84	91	84	88	91	84	84
61	C	61	61	61	80	73	85	80	85	89	80	85	85
		Frequency Number											

FREQUENCIES USED IN MANUALS

Figure 4



Figure 5: Typical 25 note pedal assembly

Pedal Switch Assembly - All Models with 25 Note Pedal Keyboard

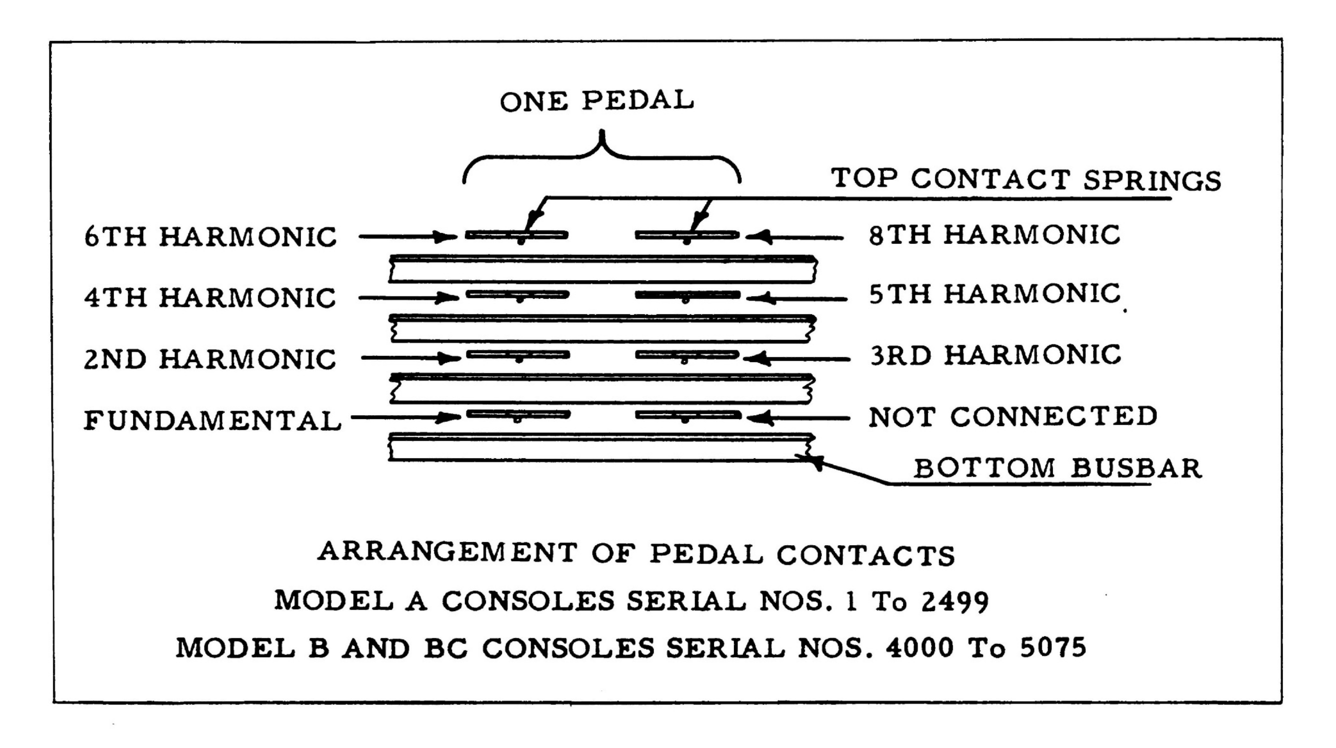
The pedal switch (shown in figure 5) is similar in construction to the manuals except that only four busbars are included instead of nine. Each of the 25 pedals actuates a double set of contact springs, making eight contacts available for each note. Each note consists of a fundamental and number of harmonics, no sub-harmonics being used. The pedal contact springs are connected to terminals by resistance wires similar to those used in the manual assembly, and a cable connects these terminals through a wiring tube to the proper terminals on the generator terminal strip.

Four colored wires carry the pedal tones from the busbars to the pedal drawbars. In some models the wires are connected first to a resistor panel on the back of the manual assembly. A small choke coil and resistor mounted on the manual assembly are wired to the lower drawbar (see figures 8, 9, 10, 11) and serve to filter out any higher harmonics or transients which might be present in the lower pedal frequencies.

Early consoles used only seven contacts on each pedal (see figure 6) and were wired so that any harmonic would appear on only one pedal drawbar (figures 8 and 9). Later consoles use all eight contacts (figure 7) and employ a system for mixing the 16 ft. and 8 ft. tones (figures 10 and 11). The harmonic arrangement of the contacts is also different in these later units.

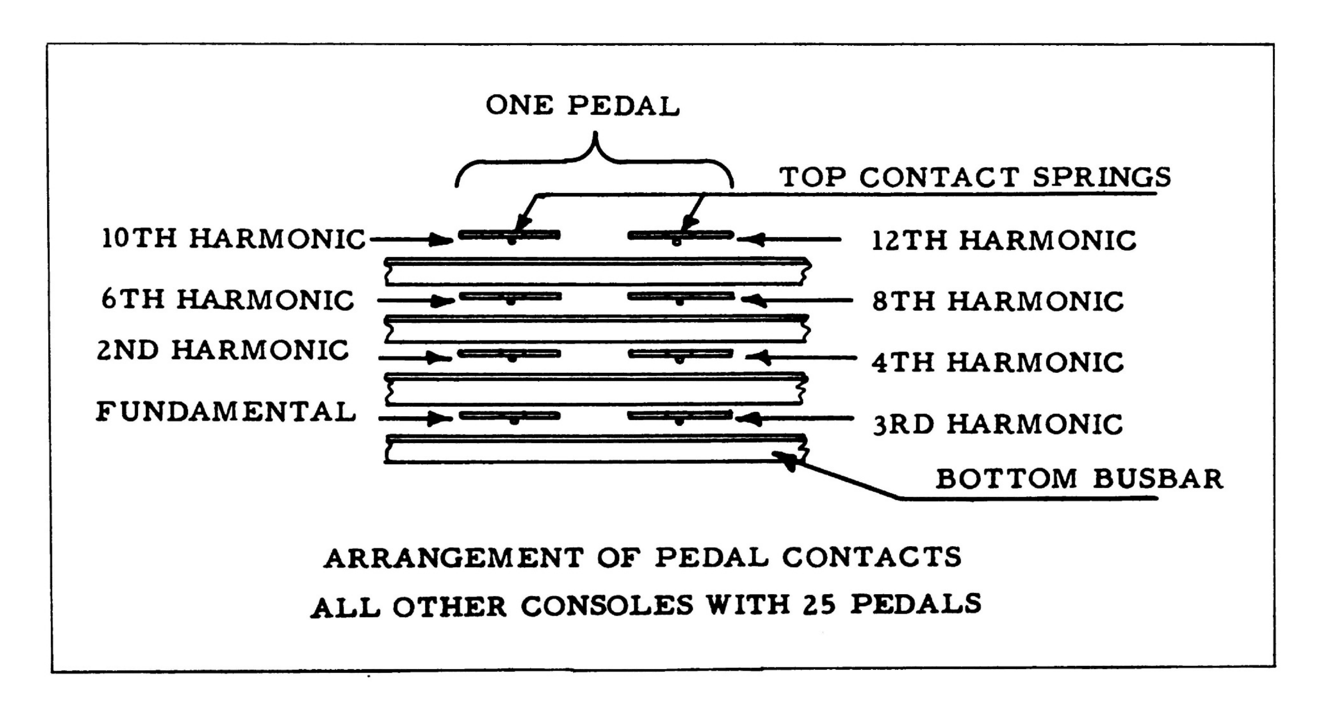
Figure 13 is a wiring chart for the pedals, showing the frequency numbers appearing on each pedal contact. The variations in wiring make the pedal switches match the different types of generators described in the section covering tone generators, and therefore the various types are not interchangeable.

Specific pedal wiring of any console can be determined by obtaining the serial number and referring to figures 8 to 11. Included in these sketches are references to figure 13 wiring chart.



ARRANGEMENT OF PEDAL CONTACTS
MODEL A CONSOLES SERIAL NOS. 1 To 2499
MODEL B AND BC CONSOLES SERIAL NOS. 4000 To 5075

Figure 6



ARRANGEMENT OF PEDAL CONTACTS
ALL OTHER CONSOLES WITH 25 PEDALS

Figure 7

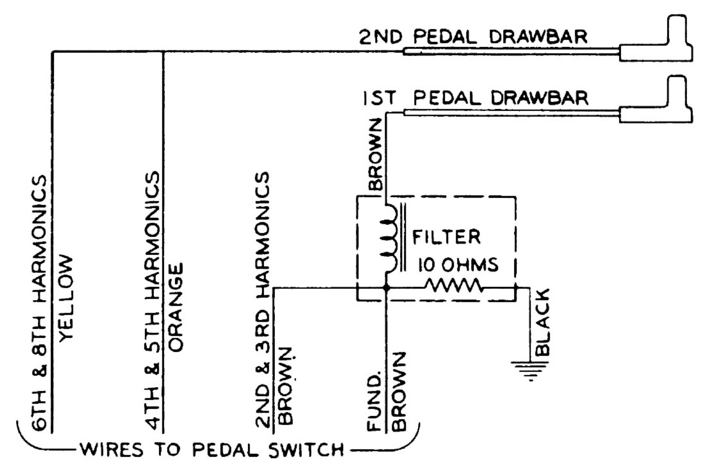


FIGURE 8 PEDAL CIRCUITS

MODEL A CONSOLES SERIAL NO. 1 TO 2499
MODEL B AND BC CONSOLES SERIAL NO. 4000 TO 5075

(FOR PEDAL WIRING SEE FIGURE 13, COLUMNS 1,4,5,6,7,8,9)

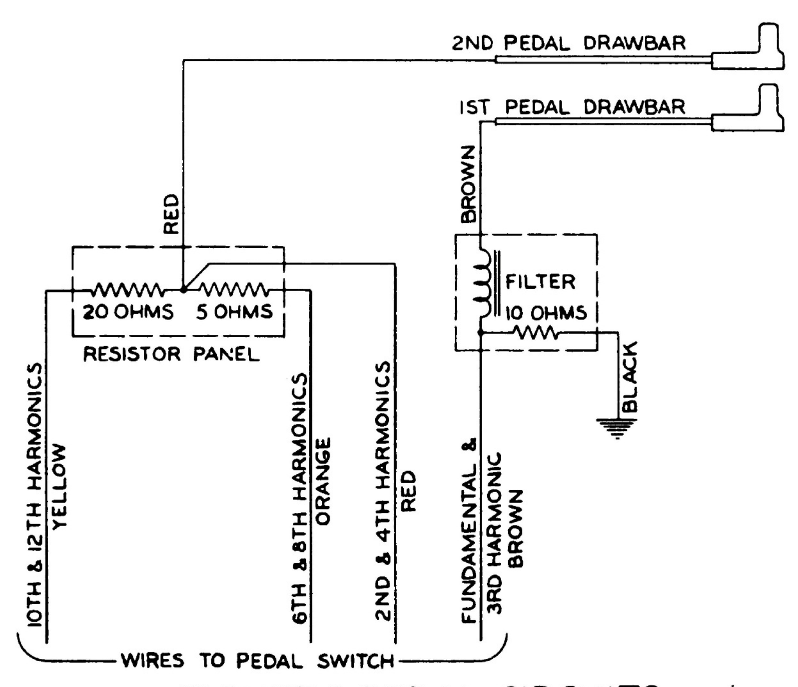


FIGURE 9 PEDAL CIRCUITS

MODEL A CONSOLES SERIAL NO. 2500 TO 2676
MODEL B AND BC CONSOLES SERIAL NO. 5076 TO 10549
MODEL BA (PLAYER) CONSOLES-ALL
MODEL C CONSOLES SERIAL NO. 1200 TO 1247
MODEL D CONSOLES SERIAL NO. 1 TO 3143
(FOR PEDAL WIRING SEE FIGURE 13, COLUMNS 1,4,5,6,8,9,10,11)

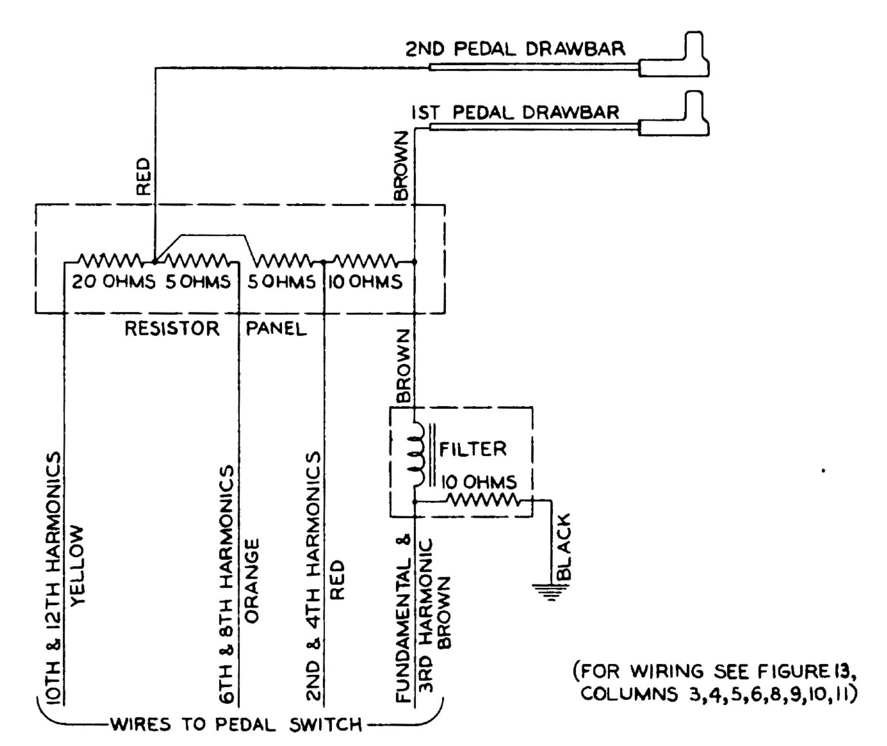


FIGURE 10 PEDAL CIRCUITS

MODEL A CONSOLES SERIAL NO. 2677 TO 2711
MODEL B, BC, AND BV CONSOLES SERIAL NO. 10550 TO 17074
MODEL C AND CV CONSOLES SERIAL NO. 1248 TO 17074
MODEL D AND DV CONSOLES SERIAL NO. 3144 TO 17074
MODEL G CONSOLES-ALL

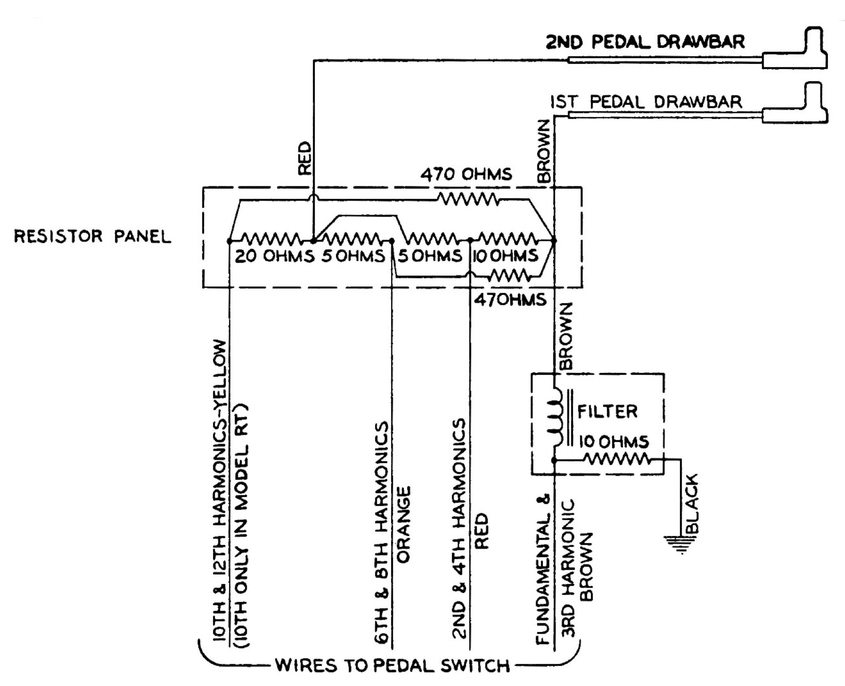
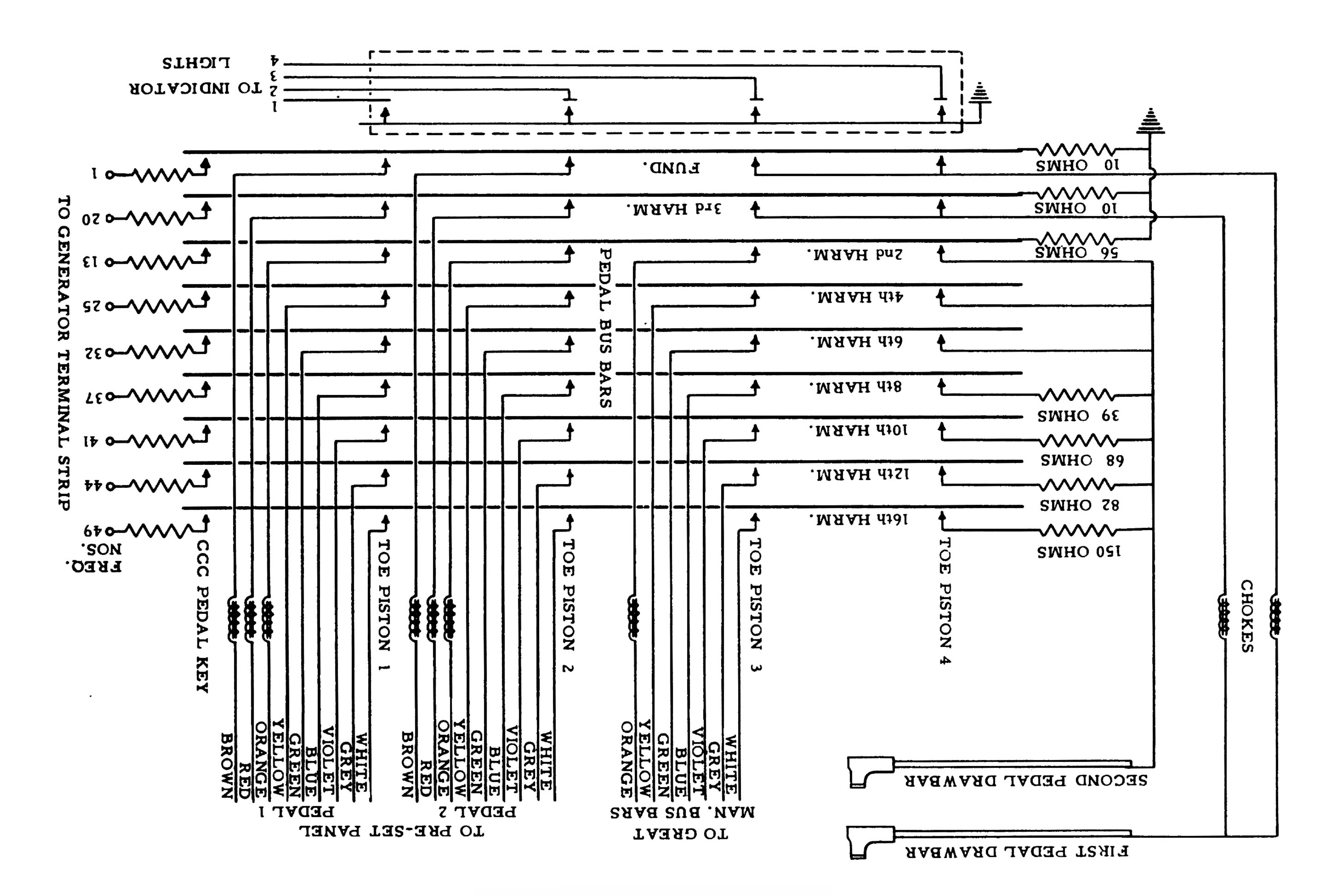


FIGURE 11 PEDAL CIRCUITS

MODEL BV AND CV CONSOLES SERIAL NO. 17075 TO 30287
MODEL RT CONSOLES SERIAL NO. 1001 TO 1201
MODEL B-2 AND C-2 CONSOLES SERIAL NO. 35000 AND ABOVE
MODEL B-3 AND C-3 CONSOLES SERIAL NO. 56000 AND ABOVE
MODEL RT-2 CONSOLES SERIAL NO. 1300 AND ABOVE
MODEL RT-3 CONSOLES SERIAL NO. 4000 AND ABOVE
(FOR PEDAL WIRING SEE FIGURE 13, COLUMNS 1,2,4,6,8,9,10,11)



WIRING OF PEDAL CIRCUITS
MODEL E CONSOLE
Figure 12

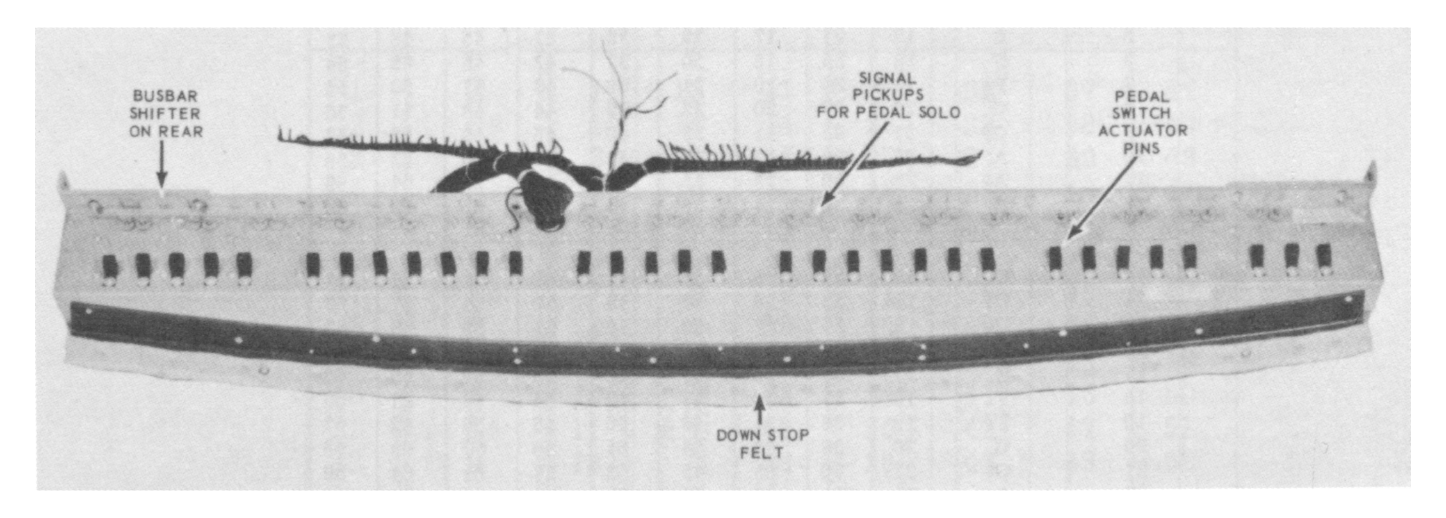


Figure 21: Concert style, 32 note pedal assembly

<u>Pedal Switch Assembly - RT, RT-2, RT-3, and D-100</u>
The pedal switch (shown in figure 21) is similar in internal construction to the manuals (figure 22). Each of the 32 pedals actuates a set of contact springs, making nine contacts available for each note. Each note consists of a fundamental and a number of harmonics, no sub-harmonics being used. The pedal contact springs are connected to terminals by resistance wires similar to those used in the manual assembly, and a cable connects these terminals to the proper terminals on the generator terminal strip. Only seven contacts are used for the mechanical generator notes, the other two contacts are used by the pedal solo unit as explained later in this book.

Four colored wires carry the pedal tones from the busbars to the pedal drawbars. The wires are connected first to a resistor panel on the back of the manual assembly. A small choke coil and resistor mounted on the manual assembly are wired to the lower drawbar (see figure 23) and serve to filter out any higher harmonics or transients which might be present in the lower pedal frequencies.

Figure 24 is a wiring chart for the pedals, showing the frequency numbers appearing on each pedal contact.

<u>Pedal Switch Assembly - Model E</u>
Nine busbars are used in the Model E pedal switch assembly. Figure 12 illustrates the arrangement of these busbars and the nine contact springs of a typical pedal key. There are 32 pedal keys, and four pedal toe pistons. These pedal toe pistons, which correspond to the preset pistons of the manuals, also have nine contact springs touching the same nine busbars and have a locking arrangement by which only one piston remains in operation at one time.

Frequencies impressed on the busbars, when a pedal is played, are picked up by the contacts of the pedal piston which is in use, and go from there to the preset panel through pistons 1 or 2 or to the drawbars through piston 4. From the coupler (Piston 3) the upper seven harmonics connect to busbars in the great manual, while the lower two connect to the lower pedal drawbar and permit it to be used with the coupler. Connections from the pedals to the manual are indicated in Figure 12. A low voltage line from the preamplifier heater transformer operates the 2.5 volt pedal preset indicator lamps through the external contacts on the pedal switch. Several filter chokes and resistors mounted on the pedal switch are wired in series with leads from the lower pedal harmonics.

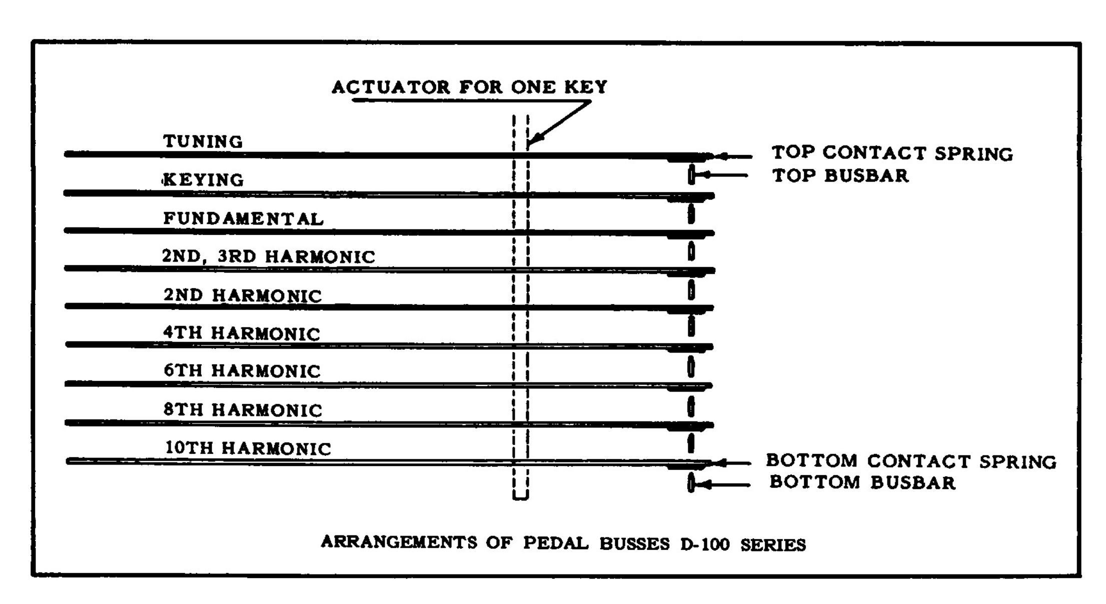


FIGURE 22

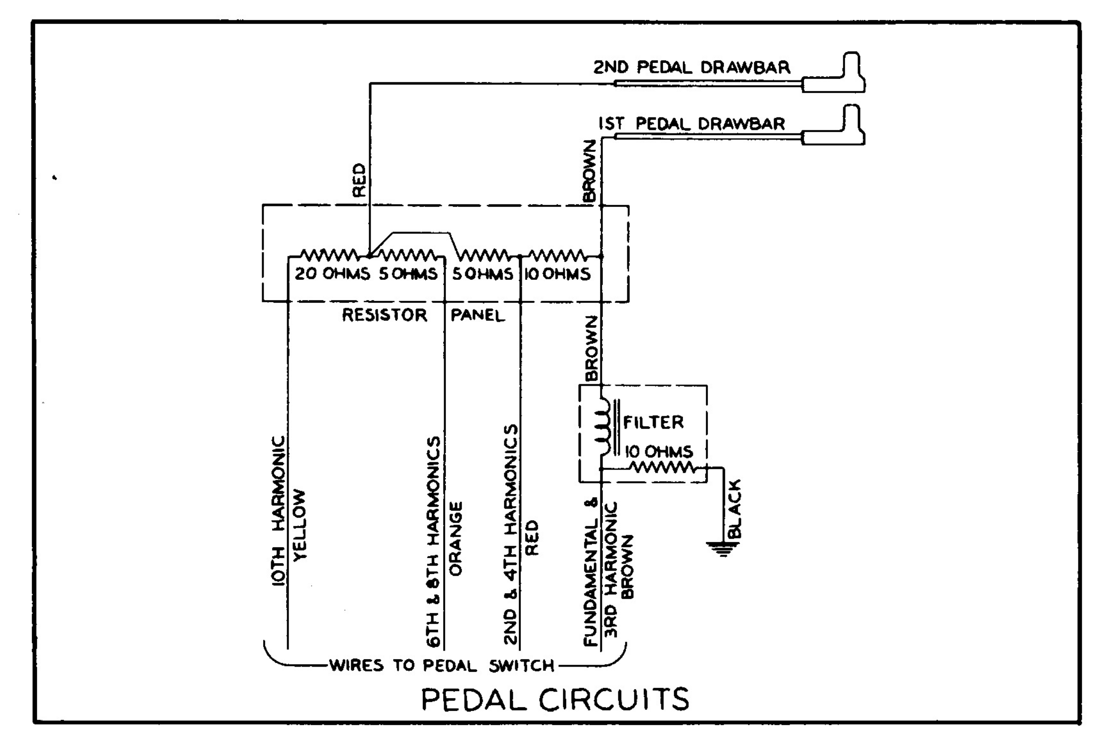


FIGURE 23

Pedal No.	Note	Fund	2nd and 3rd Harm.	2nd Harm.	4th Harm.	6th Harm.	8th Harm.	10th Harm.
1	C	1	13	13	25	32	37	41
2	C#	2	14	14	26	33	38	42
3	D	3	15	15	27	34	39	43
4	D#	4	16	16	28	35	40	44
5	E	5	17	17	29	36	41	45
6	F	6	18	18	30	37	42	46
7	F#	7	19	19	31	38	43	47
8	G	8	No connection	20	32	39	44	48
9	G#	9		21	33	40	45	49
10	A	10		22	34	41	46	50
11	A#	11		23	35	42	47	51
12	B	12		24	36	43	48	52
13	C	13	32	25	37	44	49	53
14	C#	14	33	26	38	45	50	54
15	D	15	34	27	39	46	51	55
16	D#	16	35	28	40	47	52	56
17	E	17	36	29	41	48	53	57
18	F	18	37	30	42	49	54	58
19	F#	19	38	31	43	50	55	59
20	G	20	39	32	44	51	56	60
21	G#	21	40	33	45	52	57	61
22	A	22	41	34	46	53	58	62
23	A#	23	42	35	47	54	59	63
24	B	24	43	36	48	55	60	64
25	C	25	44	37	49	56	61	65
26	C#	26	45	38	50	57	62	66
27	D	27	46	39	51	58	63	67
28	D#	28	47	40	52	59	64	68
29	E	29	48	41	53	60	65	69
30	F	30	49	42	54	61	66	70
31	F#	31	50	43	55	62	67	71
32	G	32	51	44	56	63	68	72
		Frequency Number						

FREQUENCIES USED IN PEDAL SWITCH

FIGURE 24

Pedal Switch Busbar Shifters

The pedal switch is equipped with busbar shifters similar to those on the manuals. The pedal busbar shifter is a slotted stud on the rear surface of the pedal switch, near the right end as you look in at the back. It should be adjusted as described under Manual Busbar Shifters on page 3 of this section.

Pedalclavier

Pedal keys are set at the factory for average tension, but a re adjustable to fit the requirements of the individual organist. Adjustment is accomplished by removal of the top cover at the back of the pedal keyboard and setting the tension as desired.

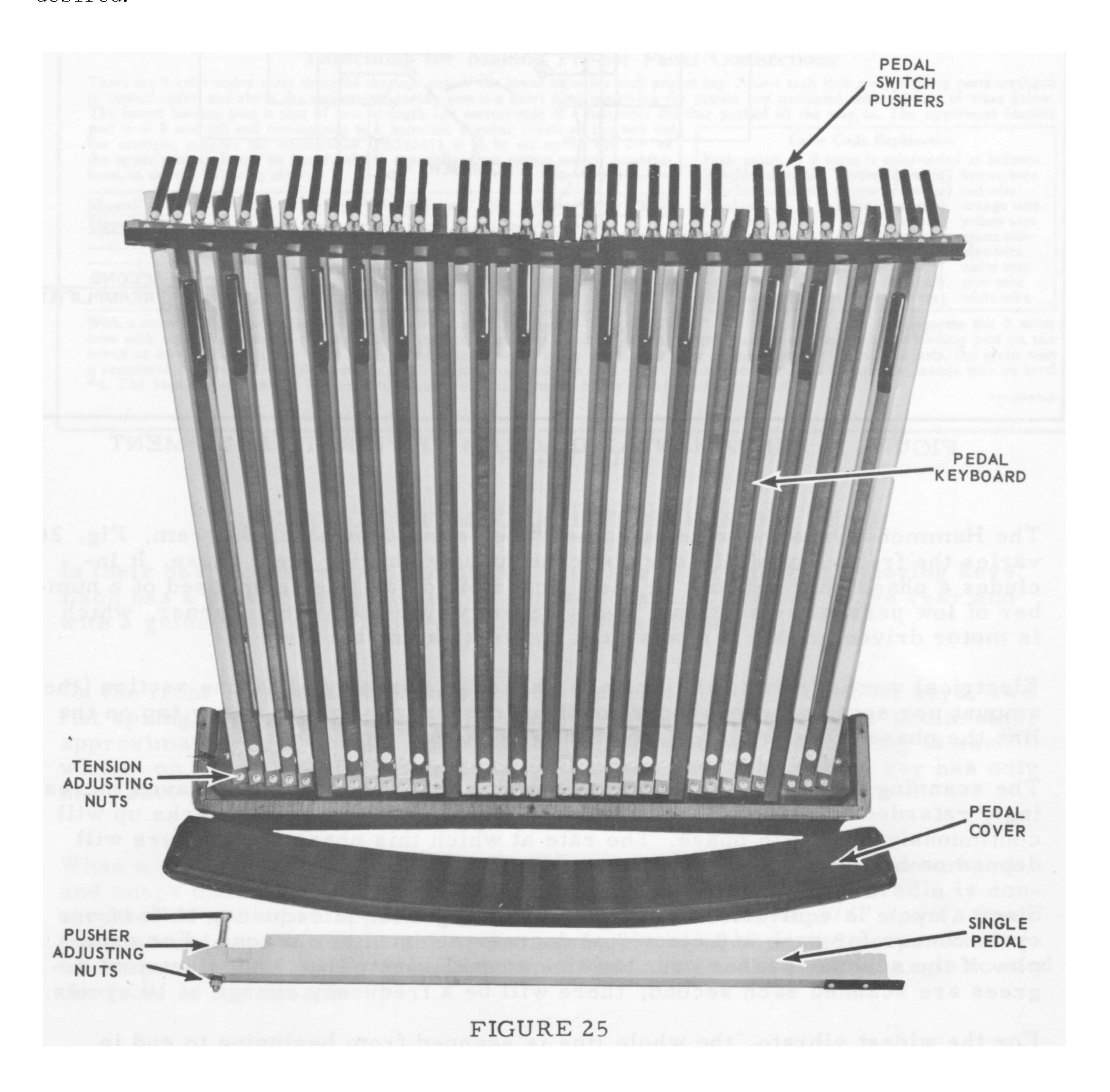


FIGURE 25

		1	2	3	4	5	6	7	8	9	10	11	12
Pedal No.	Note	Fund	2nd and 3rd Harm.	Fund and 2nd	2nd Harm.	3rd Harm.	4th Harm.	5th Harm.	6th Harm.	8th Harm.	10th Harm.	12th Harm.	16th Harm.
1	C	1	13	13	13	20	25	29	32	37	41	44	49
2	C#	2	14	14	14	21	26	30	33	38	42	45	50
3	D	3	15	15	15	22	27	31	34	39	43	46	51
4	D#	4	16	16	16	23	28	32	35	40	44	47	52
5	E	5	17	17	17	24	29	33	36	41	45	48	53
6	F	6	18	18	18	25	30	34	37	42	46	49	54
7	F#	7	19	19	19	26	31	35	38	43	47	50	55
8	G	8	No connection	20	20	27	32	36	39	44	48	51	56
9	G#	9		21	21	28	33	37	40	45	49	52	57
10	A	10		10	22	29	34	38	41	46	50	53	58
11	A#	11		11	23	30	35	39	42	47	51	54	59
12	B	12		12	24	31	36	40	43	48	52	55	60
13	C	13	32	13	25	32	37	41	44	49	53	56	61
14	C#	14	33	14	26	33	38	42	45	50	54	57	62
15	D	15	34	15	27	34	39	43	46	51	55	58	63
16	D#	16	35	16	28	35	40	44	47	52	56	59	64
17	E	17	36	17	29	36	41	45	48	53	57	60	65
18	F	18	37	18	30	37	42	46	49	54	58	61	66
19	F#	19	38	19	31	38	43	47	50	55	59	62	67
20	G	20	39	20	32	39	44	48	51	56	60	63	68
21	G#	21	40	21	33	40	45	49	52	57	61	64	69
22	A	22	41	22	34	41	46	50	53	58	62	65	70
23	A#	23	42	23	35	42	47	51	54	59	63	66	71
24	B	24	43	24	36	43	48	52	55	60	64	67	72
25	C	25	44	25	37	44	49	53	56	61	65	68	73
26	C#	26	45		38	45	50		57	62	66	69	74
27	D	27	46		39	46	51		58	63	67	70	75
28	D#	28	47		40	47	52		59	64	68	71	76
29	E	29	48		41	48	53		60	65	69	72	77
30	F	30	49		42	49	54		61	66	70	73	78
31	F#	31	50		43	50	55		62	67	71	74	79
32	G	32	51		44	51	56		63	68	72	75	80
		Frequency Number											

Pedals 26 to 32 used in Model E, RT, RT-2, RT-3 and D-100 only

For Harmonics Used In a Given Console See Fig. 8-9-10-11-12.

FREQUENCIES USED IN PEDAL SWITCHES

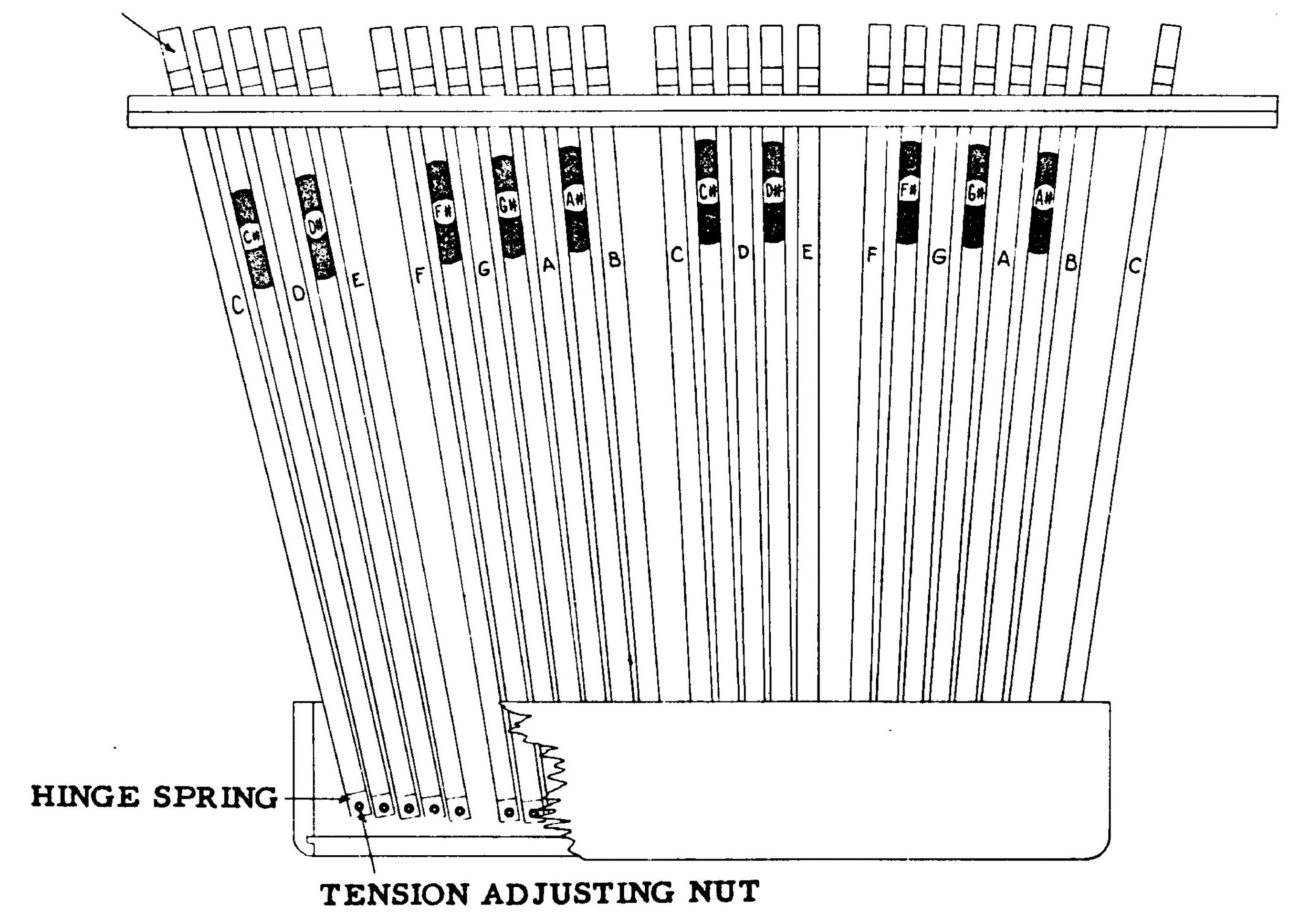
Figure 13

Pedal Busbar Shifters

Pedal switches in all consoles (except Model A consoles below serial number 995) are equipped with busbar shifters similar to those on the manuals. The pedal busbar shifter is a slotted stud on the rear surface of the pedal switch, near the left end as you look in at the back. It should be adjusted as described under Manual Busbar Shifters on page 3 of this section.

Pedal Keyboard

Pedal keys are set at the factory for average tension, but are adjustable to fit the requirements of the individual organist. Adjustment is accomplished by removal of the top cover at the back of the pedal keyboard and setting the tension nuts as desired.



PEDAL KEYBOARD

Figure 14

Preset Panel - Models A, AB, BC, BCV, BV, C, CV, D, DV, G. GV, RT

The tone signals from the preset keys on both manuals are carried by color-coded wires to the preset panel in the back of the console.

The preset panel is a set of nine bars, wired to the taps on the matching transformer, corresponding to different intensities of sound as shown by numbers stamped on the bars. Each preset wire, carrying a single harmonic, is fastened under a screw on the bar which represents the desired intensity of that harmonic. This is equivalent to setting a harmonic drawbar to the corresponding number.

Preset combinations may be changed at will by removing the console back and following the directions on a card inside. This card is reproduced below (figure 15).

Directions for Making Pre-Set Panel Connections

There are 9 color-coded wires threaded through one of the lower holes for each pre-set key. Above each hole are 9 binding posts arranged in vertical order, and above the uppermost binding post is a name plate specifying the pre-set key associated with the row of wires below. The lowest binding post is that of zero strength and corresponds to a harmonic control pushed all the way in. The uppermost binding post is of 8 strength and corresponds to a harmonic control drawn all the way out. The bus-bar strips for each level are extended to the left where they are marked with their appropriate strength numbers.

For example, suppose the combination 006523411 is to be set up on the D# of the upper manual. It will be found helpful, especially when setting several combinations, to use the following chart:—

Manual	Key	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Upper	D#	0	0	6	5	2	3	4	1	1

Color Code Explanation

Each group of 9 wires is color-coded as follows:

Sub-fundamental	(brown drawbar)	brown wire
Sub-3rd harmonic	(brown drawbar)	red wire
Fundamental	(white drawbar)	orange wire
2nd Harmonic	(white drawbar)	yellow wire
3rd Harmonic	(black drawbar)	green wire
4th Harmonic	(white drawbar)	blue wire
5th Harmonic	(black drawbar)	violet wire
6th Harmonic	(black drawbar)	grey wire
8th Harmonic	(white drawbar)	white wire

With a screw driver remove the connections already made on the D# "Upper Manual" row of binding posts and separate the 9 wires from each other. Referring to the chart above, the brown and red wires are twisted together and connected with the binding post on the level marked "O" (lowest level). Next, the white and grey wires are twisted together and inserted under the binding post on the level marked "1." Similarly, the green wire is connected on level "2," the blue wire on level "3," the violet wire on level "4," the yellow wire on level "5," and the orange wire on level "6." The wire used for the pre-set connections is standard "push-back" wire. The insulation is loose and should be pushed back to expose the desired length of bare wire. *Never remove the insulation by skinning with pliers or a knife.* After a connection has been made, push the insulation forward with the fingers as far as it will go. Be sure to twist the wires together so that there will be no stray strands connecting one bar with any other bar. The binding posts should be firmly tightened over the wires to insure good electrical contacts.

PO-2963-1

Figure 15

Preset Panel - Models B-2, B-3, C-2, C-3, RT-2, RT-3, E, A-100, D-100

In these models the preset panel is divided into two sets of nine bars, each connected to a separate matching transformer. One set is used for the swell (upper) manual, and the other for the great (lower) manual and pedals. The preset panel on Model E is slightly longer than on the other models to accommodate the two pedal presets.

Matching Transformers

The matching transformer is used to match the low impedance of the generator and key circuits to the high impedance amplifier input. It serves also, through taps on its primary winding, to establish a series of intensity levels for the drawbars and preset panel.

The following types of matching transformers have been used. In most cases they are not interchangeable, and console serial numbers should be furnished when ordering replacements.

1. Large-core transformer, used in Models A, B, BA, BC, C, D, and G. These were enclosed in two sizes of shield cans at various times, but they are identical otherwise. Two transformers of this type were used in Model E.

2. Large-core transformer with taps revised. Matching transformers in organs with non-selective vibrato (Models BV, BCV, CV, DV, and RT) are slightly different from earlier models in the number of turns to the first three taps. If a transformer in an earlier organ is replaced by one of the newer type, any preset wires on preset panel bars 1, 2, and 3 should be set to the next higher bar in order to make the combination sound the same as before. For instance, combination 00 3543 111 with the old type transformer would become 00 4544 222 with the new one.

3. Small-core transformers used in selective vibrato organs Models B-2, C-2,and RT-2 having preamplifiers code A, B and C. Two transformers are used in each organ, one with large stack for the upper or swell manual, one with small stack for the lower or great manual and pedals.

4. Revised small-core transformers with smaller stack and greater number of turns. These are used in B-2 consoles serial number 42636 and above, C-2 consoles serial number 42875 and above, and RT-2 consoles serial number 2381 and above (having preamplifiers code D, E, F, G) and in B-3, C-3, RT-3, A-100 and D-100 consoles. Because differences in the preamplifier input circuits will cause irregular response, these transformers are not interchangeable with the previous type, unless the preamplifier is changed at the same time.

OPERATION OF MECHANISM ON PRESET KEYS

In their basic construction the preset keys are identical to the playing keys. Each has a plastic key mounted on a metal channel, pivoted in the rear and with a guide toward the front to minimize side motion.

On the front edge of each channel of the 9 preset keys and 2 adjust keys, two flat springs are attached, one 5/8″ long of rather stiff material, and another approximately 3/4″ long of softer material. The softer long spring is sandwiched on top of the stUf spring, nearest to the key. The cancel key has only one heavy spring approximately 1″ long.

When a preset key is depressed, the longer soft spring is forced downward and snaps under a tubular rod which is part of the cradle. The cradle is constructed of two tubes approximately 6- long and assembled 3/4 - apart. One tube is used as a fulcrum, the entire assembly being mounted perpendicular to the preset keys. A spring and bumper hold the cradle at a 60 degree angle toward the front of the console.

Once a key has been depressed, the soft spring remains under the tube. It is backed by the short stiff spring to give it sufficient tension to hold the key down. When the next preset key is depressed, the cradle is forced down and outward, permitting the previously actuated key to come up, but again locking the one last depressed.

If two preset keys are depressed at once, both will lock down. The cancel key with its long stiff spring is then used and forces the cradle down, causing all preset keys depressed to return to their normal position. As there is no locking spring on the cancel key, it will immediately return to its normal position.

PRESET CRADLE RETURN SPRING

Earlier instruments had coil springs of various types to perform the function of returning the cradle assembly to its rest position, and replacement, when necessary, became rather involved.

A more durable spring has been devised, and is used on the later instruments. It can also be used for servicing the earlier consoles.

Replacement is made as follows: If it is determined that a new return spring is necessary, on either manual, the left hand end block of the manual needing the replacement should be removed. The upper or lower manual assembly will have to be raised to gain access to the wood screws holding this block. After removal of this block, the end of the cradle assembly will be visible. Also visible will be the stop felt and bracket assembly. This is a small angular bracket with a small piece of felt rivited to it, mounted in a vertical position. Remove and discard this part.

Install the new assembly so that the felt pad is above the preset cradle, and the flat spring is below the cradle, as shown in figure 16. Clamp it in the center of the range of adjustment provided by the slot. Check all preset keys for operation, and adjust the position of the new assembly in case any keys do not operate correctly.

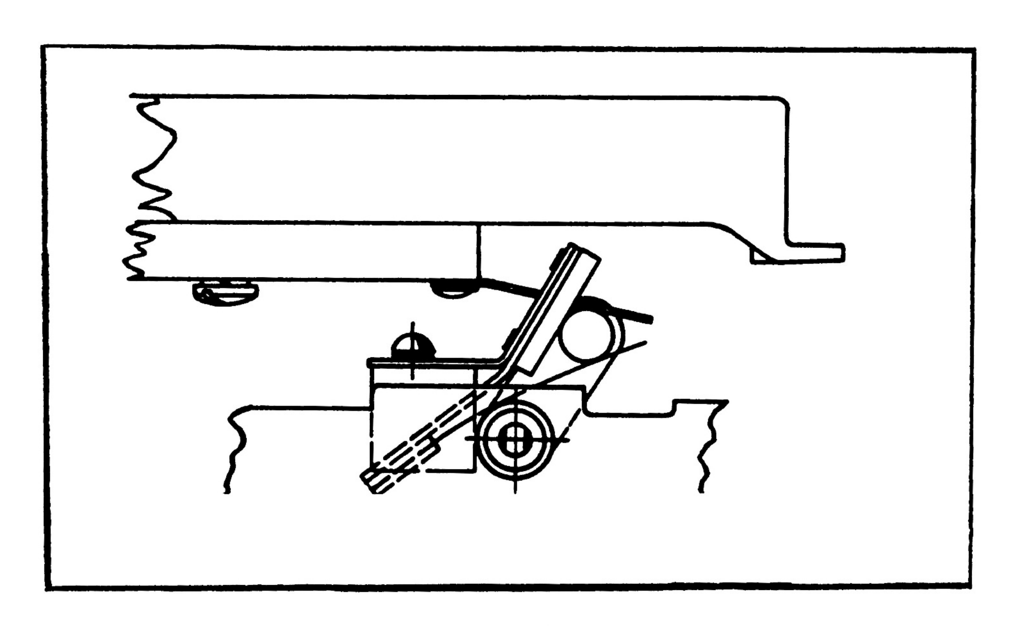
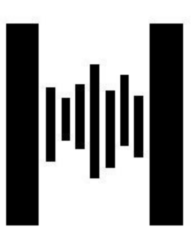


Figure 16

THE HAMMOND ORGAN

– 9 –

TREMULANT
&
RHEOSTAT BOX



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

TREMULANT SWITCH & CONTROL
MODELS A, AB, BC, C, D, G

The tremulant sometimes called tremolo, is a periodic loudness variation, or change in intensity. which occurs at a constant frequency. It is fundamentally different from the vibrato effect, which is created by a periodic raising and lowering of pitch.

In the Hammond Organ, the tremulant effect is produced and controlled principally by two components: the tremulant switch and the tremulant control.

The tremulant switch, mounted on the synchronous motor at the extreme left end of the tone generator, is in effect a variable resistor with no sliding or rubbing contacts. It consists of an eccentric, geared to the motor shaft, which advances a laminated bakelite strip so as to alternately make and break 6 contacts in order. Five resistors are connected to these contacts, ranging in value from 15,000 to 450,000 ohms, together with a length of copper wire of very little resistance. At one extreme position of the eccentric all contacts are broken and the circuit is open. At the other extreme all contacts are closed and there is practically no resistance in the circuit.

The tremulant control, a 130,000 ohm variable resistor mounted on the manual chassis assembly, is in parallel with the tremulant switch. When this control is turned to a position of no resistance, the tremulant switch is shorted out. Conversely, when the control is turned to its maximum resistance, the movement of the eccentric varies the resistance of the circuit periodically from 0 to 130,000 ohms. This parallel circuit is in series with the signal from the console, ahead of the pre-amplifier. Therefore, the signal is varied during each revolution of the eccentric by an amount depending upon the adjustment of the tremulant control. The tremulant system is not used in console models having vibrato.

Concert Model E

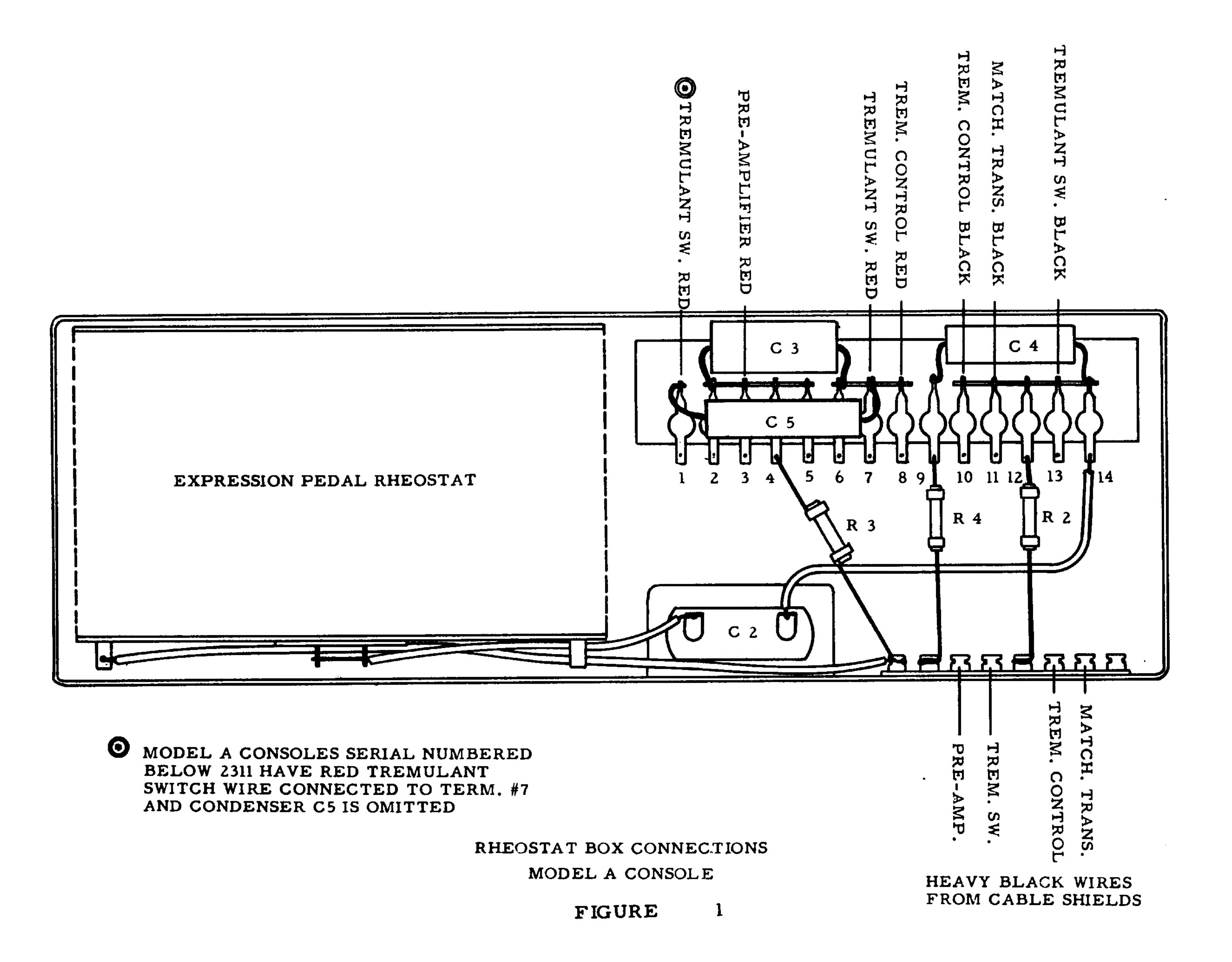
The tremulant system for Model E organ is the same as that on other models except that two switches are used. Each switch is mounted on one of the two synchronous motors that are a part of the main generator and chorus generator respectively, and each one is connected to one manual. The switch mounted on the main generator operates at 400 R.P.M. and is connected to the Great manual. The other switch operates at 348 R.P.M. and is connected to the Swell manual. Two types of tremulant switches have been supplied, namely, the cage type and the enclosed type. These are mechanically interchangeable, but replacing the cage type with the enclosed type does require a slight change in the circuit. In the enclosed type, the condenser shown as C5 in figure 4 is incorporated within the metal housing. Therefore, the C5 located in the rheostat box is not required and the tremulant switch red wire may be attached to terminal 6,7, or 8.

RHEOSTAT BOX

The rheostat box contains the expression control rheostat and other components. including some terminals associated with the tremulant system. Figures 1 to 8 show various models of rheostat boxes and their circuits. The rheostat box is used only in console models with tremulant and with non-selective vibrato .

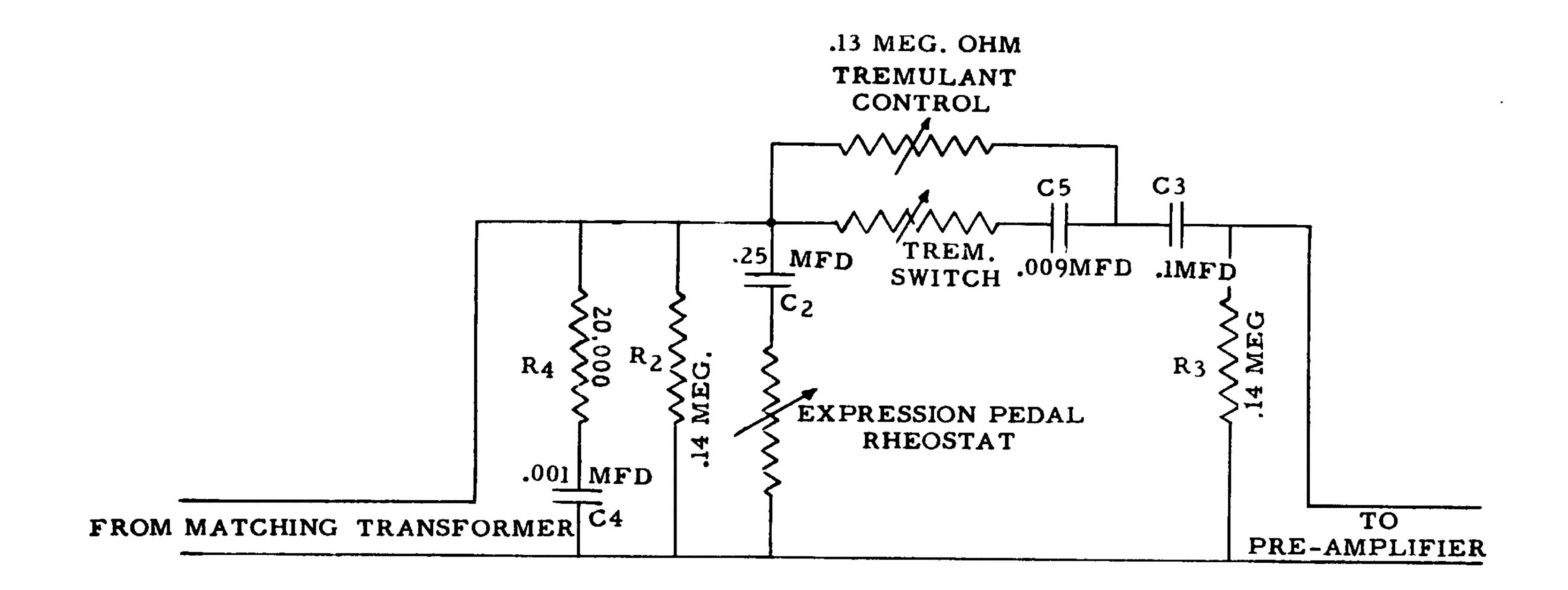
The rheostat itself is actually a variable resistor with no sliding contacts. When the expression pedal is advanced a bakelite cam moves down, opening in succession a series of 32 contacts. tipped with precious metal. The contacts are connected to fixed carbon resistors.

Resistor R2 in figures 2 and 4 forms a constant load on the matching transformer, while R4 and C4 serve to attenuate the higher frequencies. R4 and C4 were not used in Model A consoles below serial number 1231. The rheostat, in series with bass compensating condenser C2, is across the signal line so that when its resistance is least the volume is least. Condenser C5 avoids excessive tremolo on the lower bass frequencies. It was not originally installed in Model A consoles below serial number 2311. C3 is a blocking condenser and R3 is a grid resistor for the first preamplifier tube.



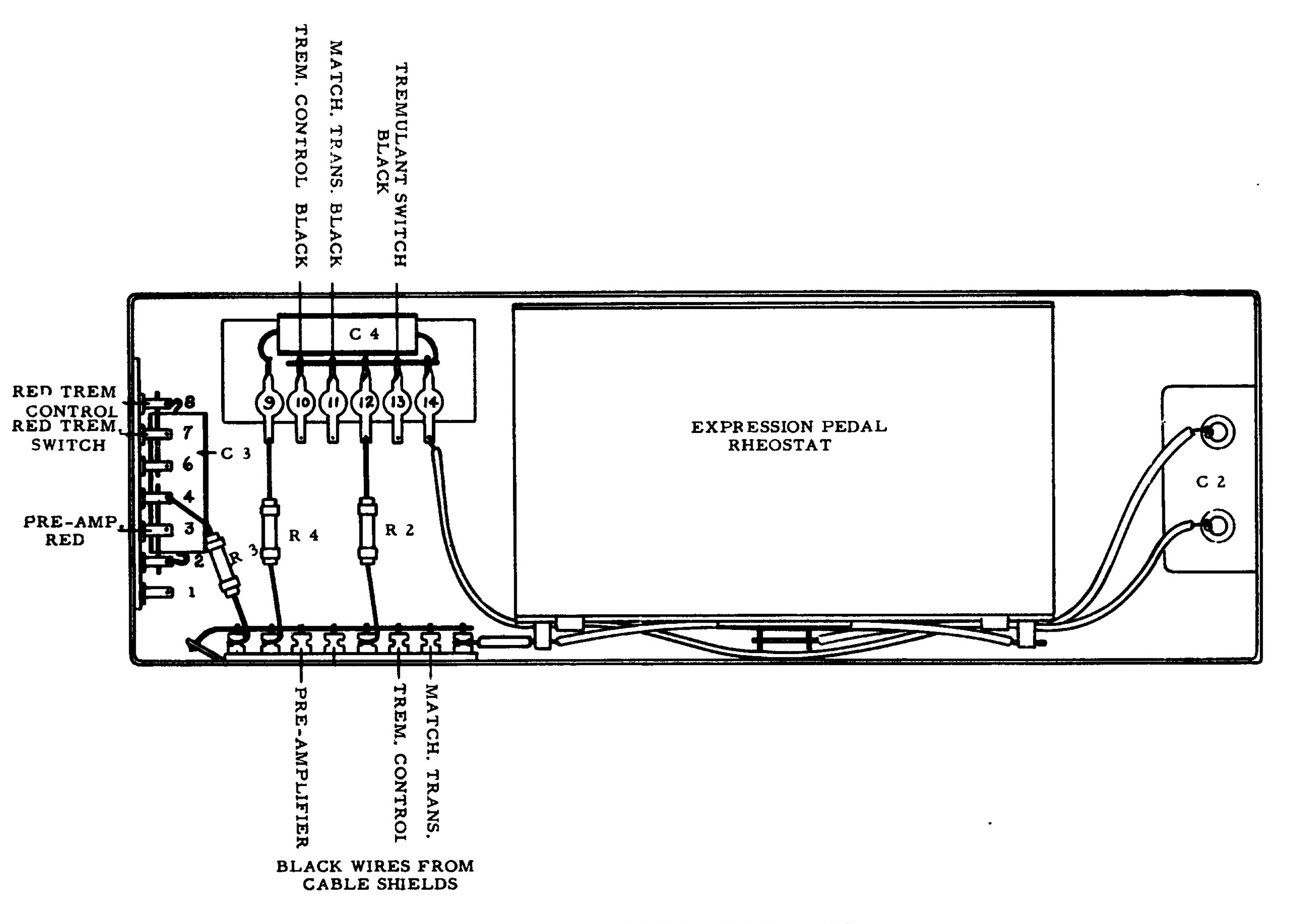
MODEL A CONSOLES SERIAL NUMBERED BELOW 2311 HAVE RED TREMULANT SWITCH WIRE CONNECTED TO TERM. #7 AND CONDENSER C5 IS OMITTED

RHEOSTAT BOX CONNECTIONS
MODEL A CONSOLE
FIGURE 1

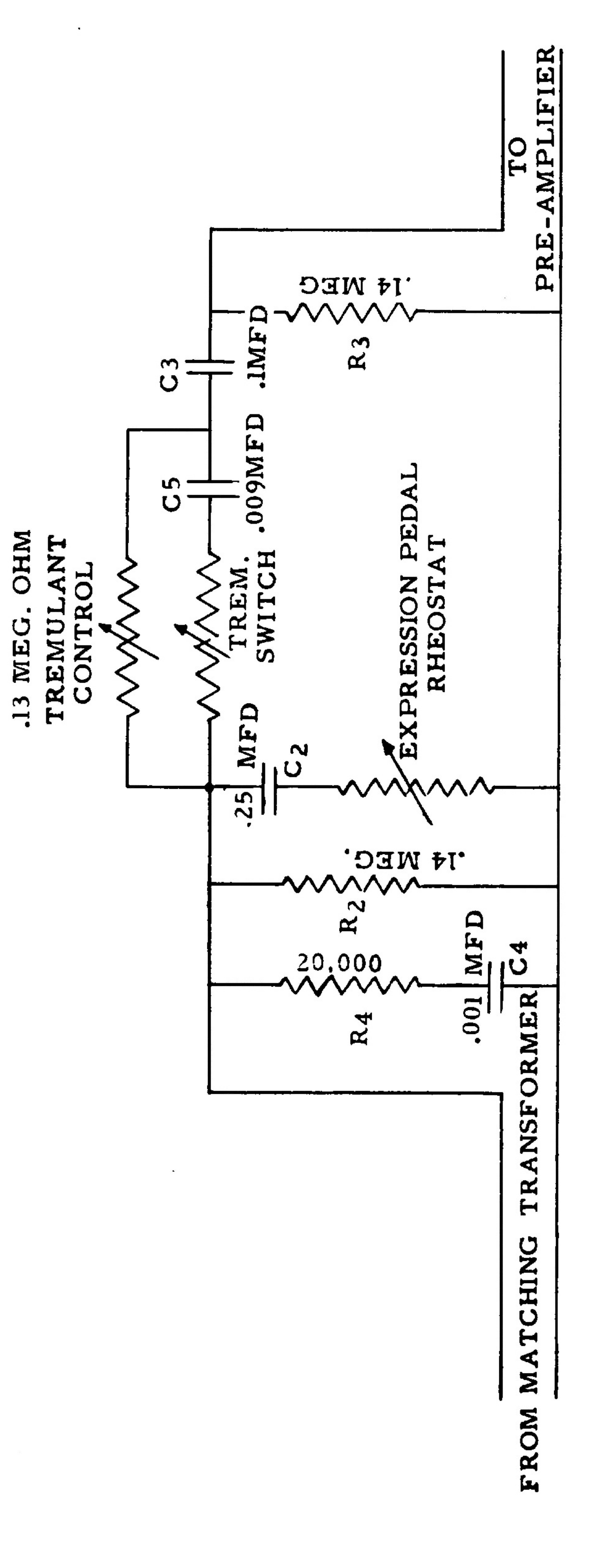


CIRCUIT OF RHEOSTAT BOX
MODEL A CONSOLE

FIGURE 2

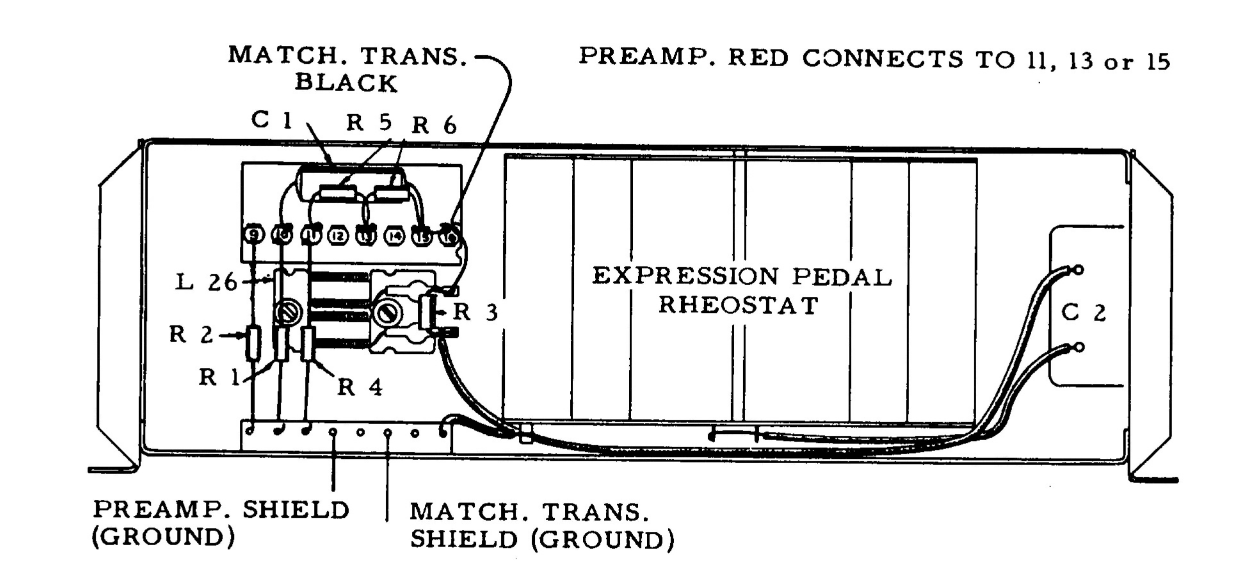


RHEOSTAT BOX CONNECTIONS
MODEL B-BA-BC-C-D-G
FIGURE 3



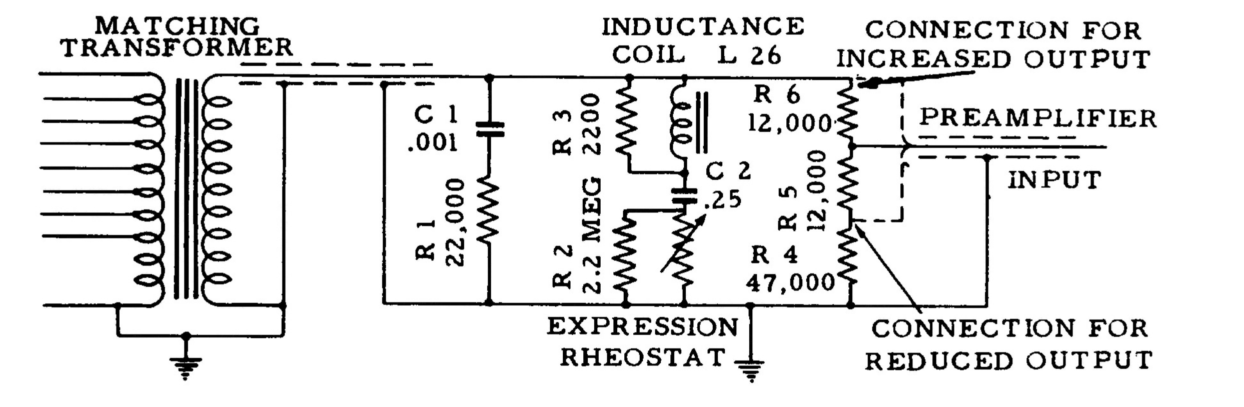
CIRCUIT OF RHEOSTAT BOX
MODEL B-BA-BC-C-D-G

FIGURE 4



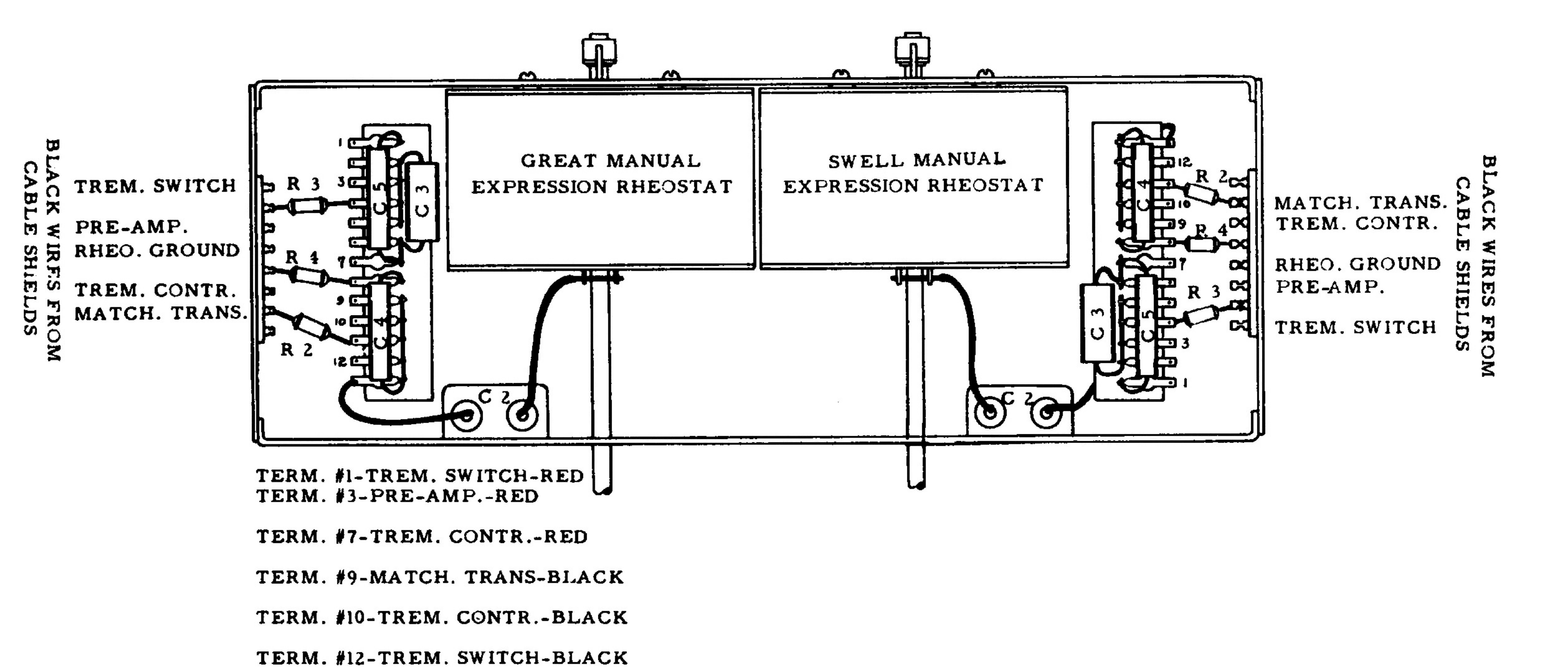
RHEOSTAT BOX CONNECTIONS
MODELS AV-BV-BCV-CV-DV-GV-RT CONSOLES

FIGURE 5



CIRCUIT OF RHEOSTAT BOX
MODELS AV-BV-BCV-CV-DV-GV-RT CONSOLES

FIGURE 6



TERM. #1-TREM. SWITCH-RED
TERM. #3-PRE-AMP.-RED

TERM. #7-TREM. CONTR.-RED

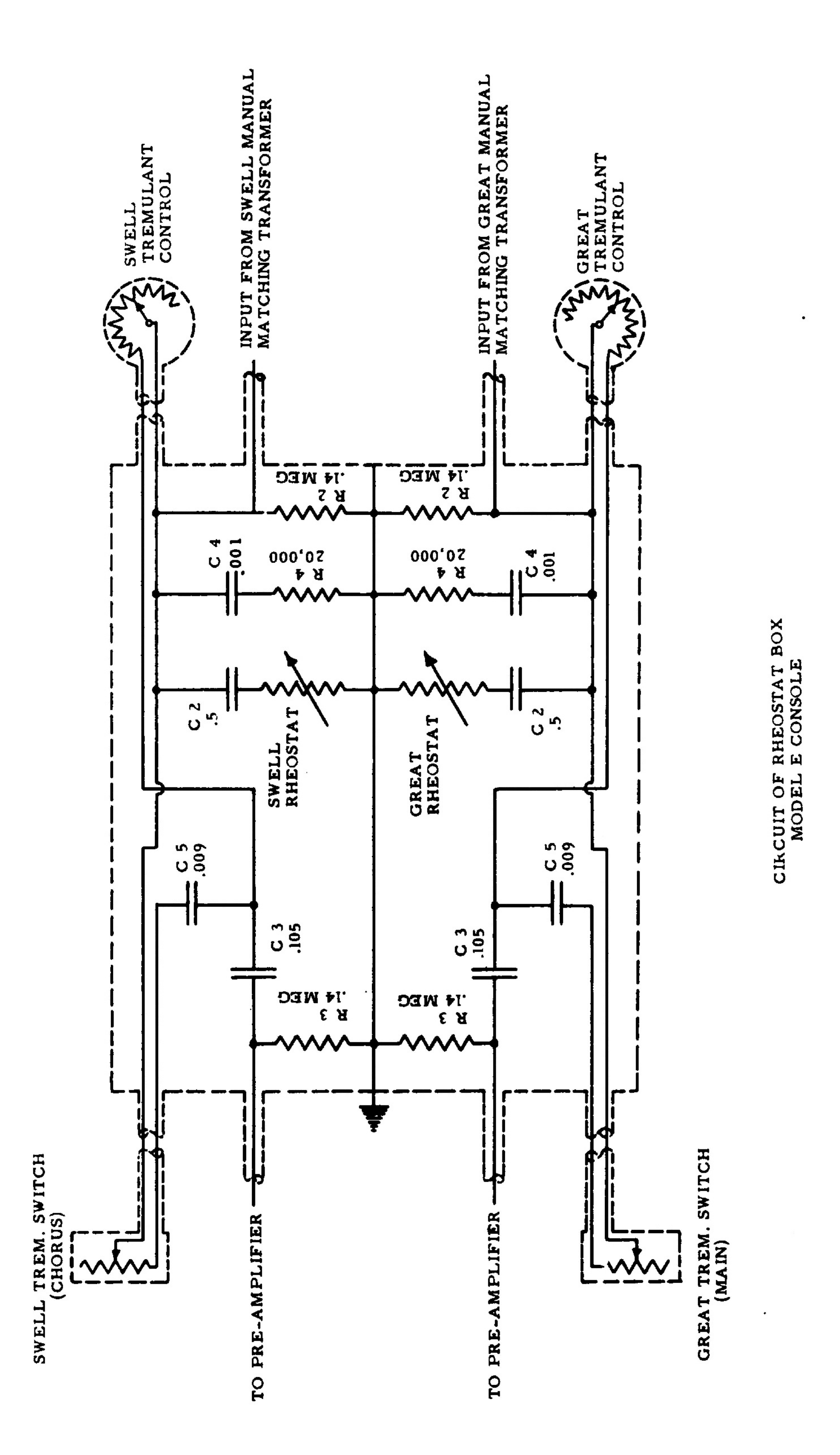
TERM. #9-MATCH. TRANS-BLACK

TERM. #10-TREM. CONTR.-BLACK

TERM. #12-TREM. SWITCH-BLACK

RHEOSTAT BOX CONNECTIONS
MODEL E CONSOLE

FIGURE 7



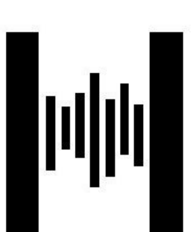
CIRCUIT OF RHEOSTAT BOX
MODEL E CONSOLE

FIGURE 8

THE HAMMOND ORGAN

– 10 –

VIBRATO
&
PERCUSSION



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Illinois
USA

THE HAMMOND VIBRATO

Hammond Organ consoles equipped with vibrato differ from tremulant models in the omission of the tremulant switch, tremulant control, and non-vibrato preamplifier, and in the addition of the vibrato line box, scanner, vibrato switch, and vibrato preamplifier. Three degrees of vibrato are available and also a different degree of chorus or celeste effect with each of the three degrees of vibrato. Console models with the suffix -2 in their model designation have the selective vibrato feature, with tilting control tablets permitting the player to place the vibrato effect on either manual or both.

A conversion kit is available for installation in most earlier consoles not having the vibrato. but it does not incorporate the selective feature.

PRINCIPLE OF OPERATION

The vibrato effect is created by a periodic raising and lowering of pitch, and thus is fundamentally different from a tremolo, or loudness variation. It is comparable to the effect produced when a violinist moves his finger back and forth on a string while playing. Varying the frequency while maintaining constant volume.

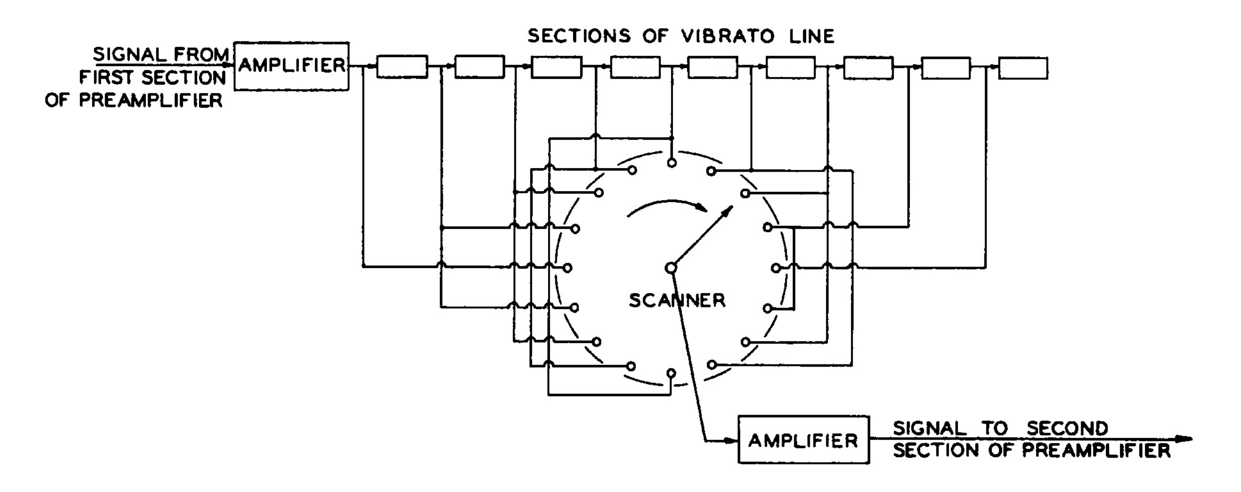


Figure 1 - FUNDAMENTAL DIAGRAM OF VIBRATO EQUIPMENT

The Hammond Organ vibrato equipment (see simplified block diagram figure 1) varies the frequency of all tones by continuously shifting their phase. It includes a phase shift network or electrical time delay line, composed of a number of low pass filter sections, and a capacity type pickup or scanner which is motor driven so that it scans back and forth along the line.

Electrical waves fed into the line are shifted in phase by each line section (the amount per section being proportional to frequency), so that at any tap on the line the phase is retarded relative to the previous tap.

The scanning pick-up traveling along the line will thus encounter waves increasingly retarded in phase at each successive tap, and the signal it picks up will continuously change in phase. The rate at which this phase shift occurs will depend on how many line sections are scanned each second.

Since a cycle is equivalent to 360 electrical degrees, a frequency shift of one cycle occurs for each 360 electrical degrees scanned per second. For example, if the scanner passes over the line at such a rate that 3600 electrical degrees are scanned each second, there will be a frequency change of 10 cycles.

For the widest vibrato. the whole line is scanned from beginning to end in about 1/14 second, and this rate of change of phase causes about 1 ½ decrease in frequency. Note that the frequency remains constantly 1 ½ low as long as the moving pick-up retards the phase at a constant rate.

Since the pick-up sweeps from start to end of the line and then back, it increases the frequency by an equal percentage on its return trip, the average output frequency remaining equal to the input frequency. The exact amount of frequency shift depends not only on the amount of phase shift in the line but also on the scanning rate. This rate, however, is constant because the scanner is driven by the synchronous running motor of the organ.

The degree of vibrato (or amount of frequency shift) may be varied by a switch (not shown in figure 1) which causes the whole line to be scanned for #3 (wide) vibrato. about half of it for #2. and about one third for #1.

A vibrato chorus effect, similar to the effect of two or three slightly out-of-tune frequencies mixed together, is obtained when the vibrato output signal is mixed with a portion of signal without vibrato. For vibrato chorus, part of the incoming signal appears across the vibrato line and the rest across a resistor in series with the line. As the vibrato effect is applied to the part of the signal appearing across the line but not to the part appearing across the resistor, the combination produces a chorus effect. For normal vibrato, this resistor is short-circuited.

In selective vibrato consoles the vibrato effect can be applied to either manual separately or to both at once.

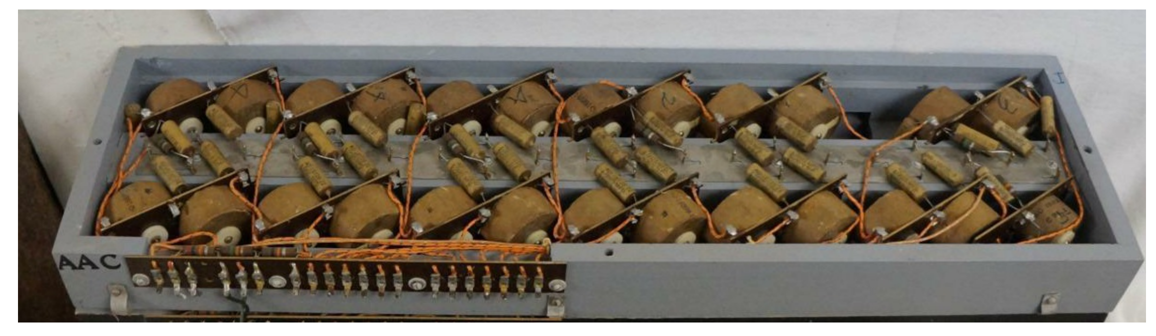
CONSTRUCTION OF COMPONENTS

Figures 2 and 3 show different models of the vibrato line box. Each of the air core inductance coils is connected with one or more condensers to form one filter section.

Figure 4 shows the construction of a typical vibrato switch. Some models differ in wiring and number of contacts, but all are similar in mechanical arrangement.

The scanner (figure 5) is mounted on the main generator synchronous motor and driven at 412 revolutions per minute. It is a multi-pole variable condenser with 16 sets of stationary plates and a rotor whose plates mesh with the stationary ones. In figure 5B two sets of plates have been removed to show the rotor.

Signals coming from the line through the vibrato switch appear on the stationary plates and are picked up, one at a time, by the rotor. Connection to the rotor is made by carbon brushes as shown in figure 5A. Two brushes touch the sides of the contact pin and a third presses on the end, in order to eliminate the possibility of contact failure.



21------Line Tap and Terminal Numbers-----1

Figure 2
Vibrato Line Box
used with circuits shown in Figures 6,7,8

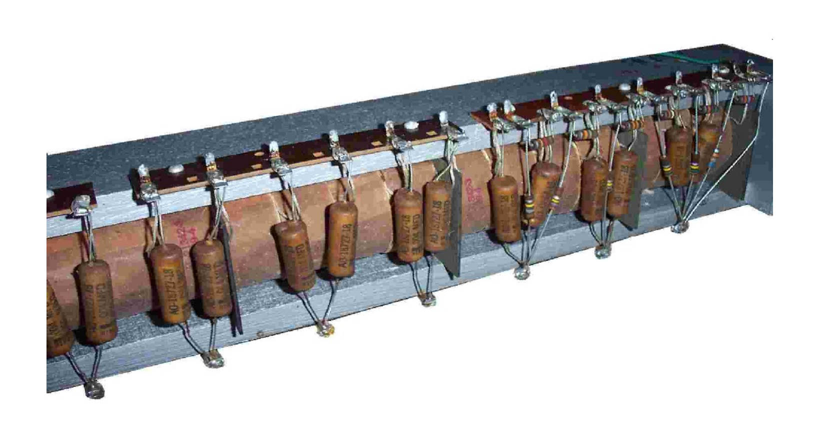


Figure 3
Vibrato Line Box
Used with circuit shown in Figure 9



Figure 3a
Vibrato Line Box
Used in B3, C3, RT-3 after c.1957 and all
A-100 and D-100 organs

These pictures are to represent style design only

SCHEMATIC DIAGRAMS

Figures 6, 7, 8 and 9 show four different vibrato circuits which have been used in various models. As the components of different types are generally not interchangeable, it is important the model and serial number be furnished when ordering replacement parts.

Non-Selective Vibrato

Figure 6, used in all consoles with -V in the model designation, has a 25 section vibrato line. It is wired (to minimize the number of compensated pick-off points) so that the last part of the line is used for #1 vibrato. The vibrato switch has positions for three degrees of vibrato (VI, V2 and V3) with three off positions between them, and there is a separate vibrato chorus switch. A resistor connected to the off side of the chorus switch serves to maintain constant volume for the two switch positions. The switch is not intended to be left in its middle position.

The preamplifier used with this circuit is actually two separate cascaded amplifiers on one chassis, with the vibrato system connected between them. The first section drives the vibrato line, and the second section amplifies the signal picked up by the scanner. The vibrato off contact in the vibrato switch carries non-vibrato signal directly to the second section of the preamplifier. The complete schematic circuit of a console of this type is shown in figure 7 of Section 2, and the preamplifier in figure 6 of Section 16, Part 2.

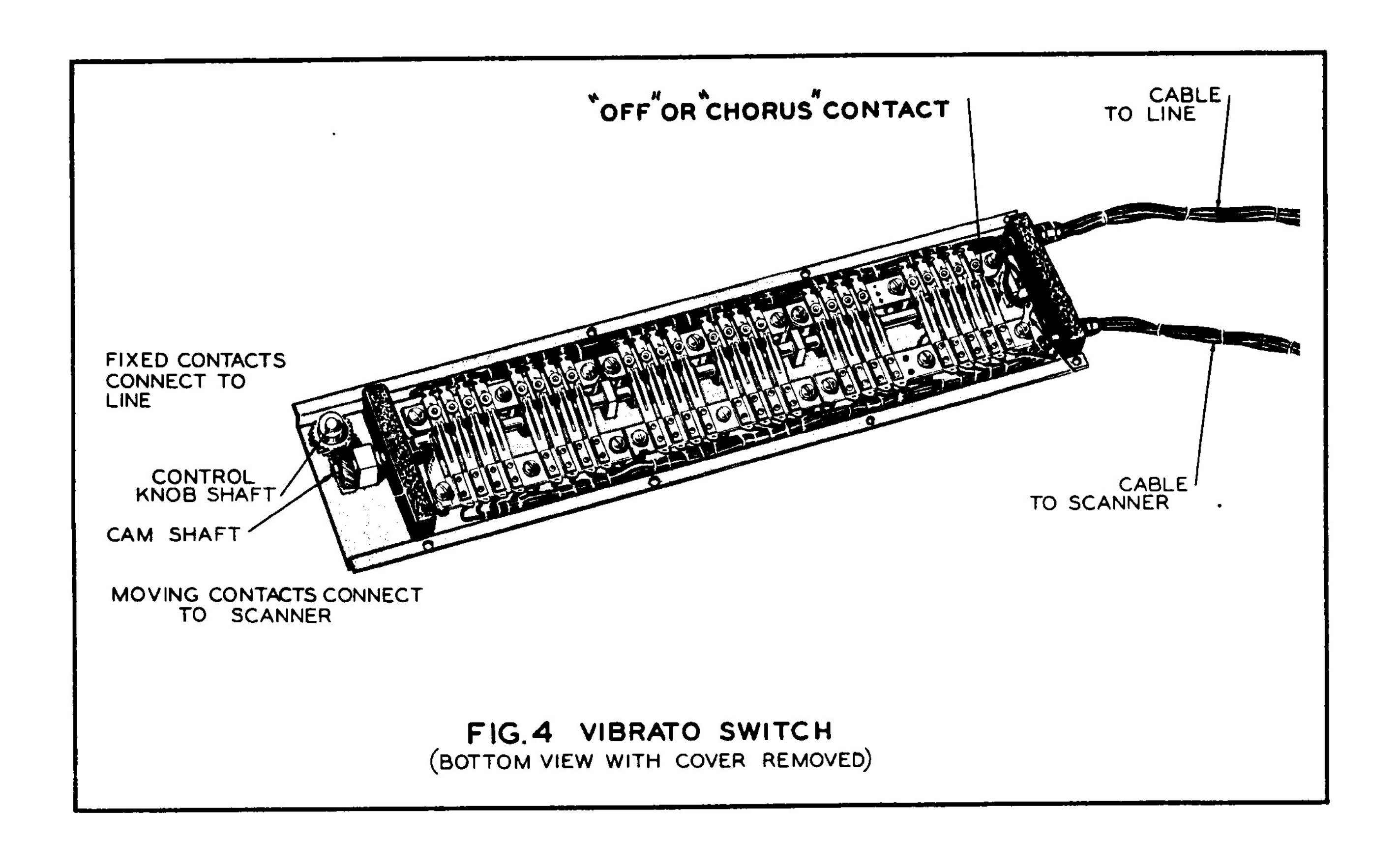


FIG. 4 VIBRATO SWITCH
(BOTTOM VIEW WITH COVER REMOVED)

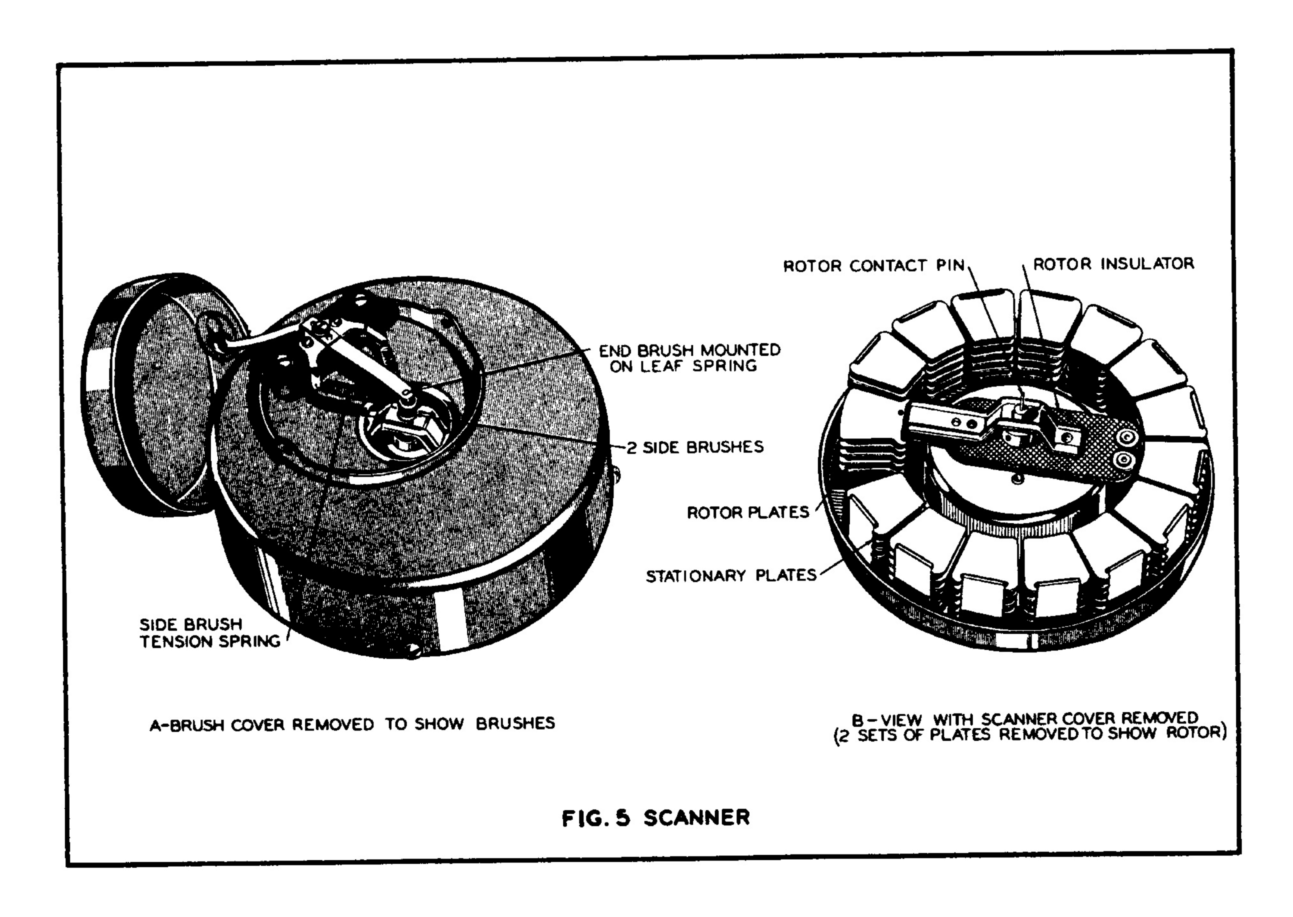


FIG. 5 SCANNER

Selective Vibrato

Figure 7, used in early selective vibrato consoles, also has a 25 section line. To obtain correct phasing of the vibrato and no vibrato channels, the first part of the line is used for #1 vibrato. The vibrato switch has no off position, and three vibrato chorus positions (C1, C2 and C3) are included in it as well as the three vibrato positions (VI, V2 and V3). The vibrato effect is turned on and off each manual separately by means of vibrato swell and vibrato great tablets on the manual assembly.

The preamplifier used with this circuit, has two separate channels into which signals from the vibrato great and vibrato swell tablets are fed. The vibrato signal goes through a preliminary amplifier, through the vibrato system, and then into additional stages of amplification. The no vibrato signal also has a preliminary amplifier, but bypasses the vibrato system and goes directly into the additional amplifier stages. The preamplifier alone is shown in figures 20 and 20A of Section 16, Part 2.

Line with Resistor Dividers

The vibrato line box of figure 8 employs resistors for voltage dividers at the compensated pick-off points instead of condensers. Otherwise this circuit is identical with that of figure 7. The line boxes of these two types are interchangeable, and the scanners and switches are identical.

Coupled Line

Figure 9 shows the coupled-coil type of vibrato line box. It is smaller in size and requires only 18 sections to give the same amount of vibrato effect as the 25 sections previously used. The switch has one less contact in each position, and so neither the vibrato line nor the vibrato switch is interchangeable with earlier types. The preamplifier are the same as those used with the circuits of figures 7 and 8. The scanner has somewhat different wiring harness.

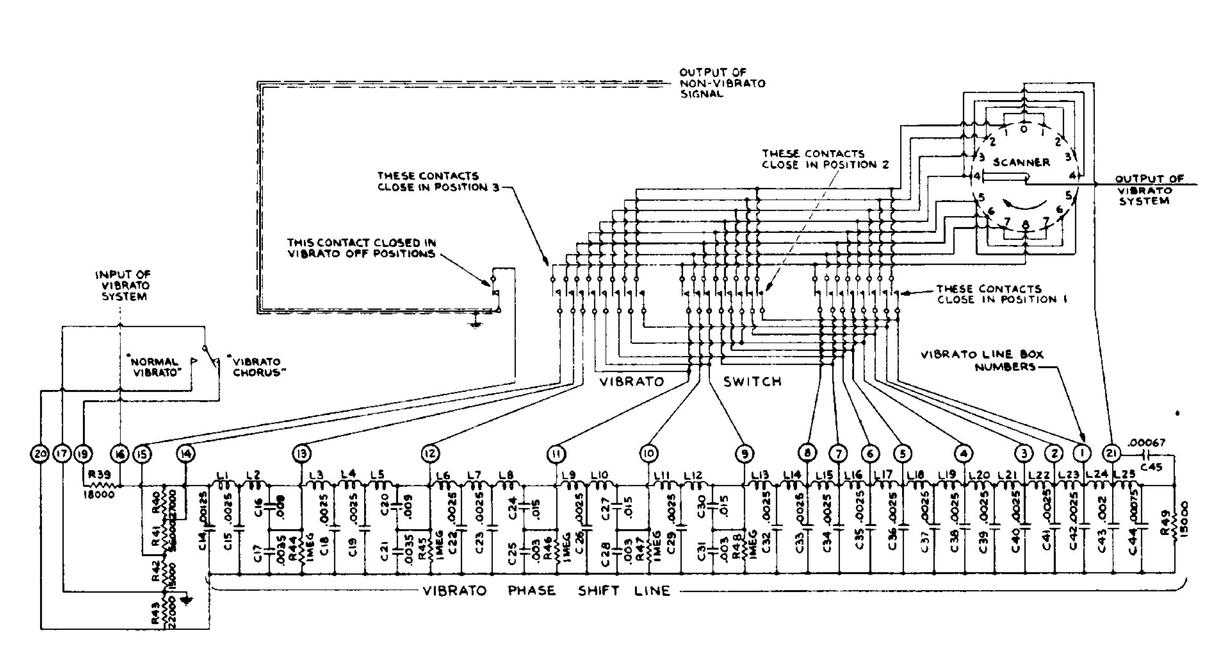


FIGURE 6 - VIBRATO SYSTEM

USED IN ALL MODEL AV, BV, BCV, CV, DV, AND RT CONSOLES

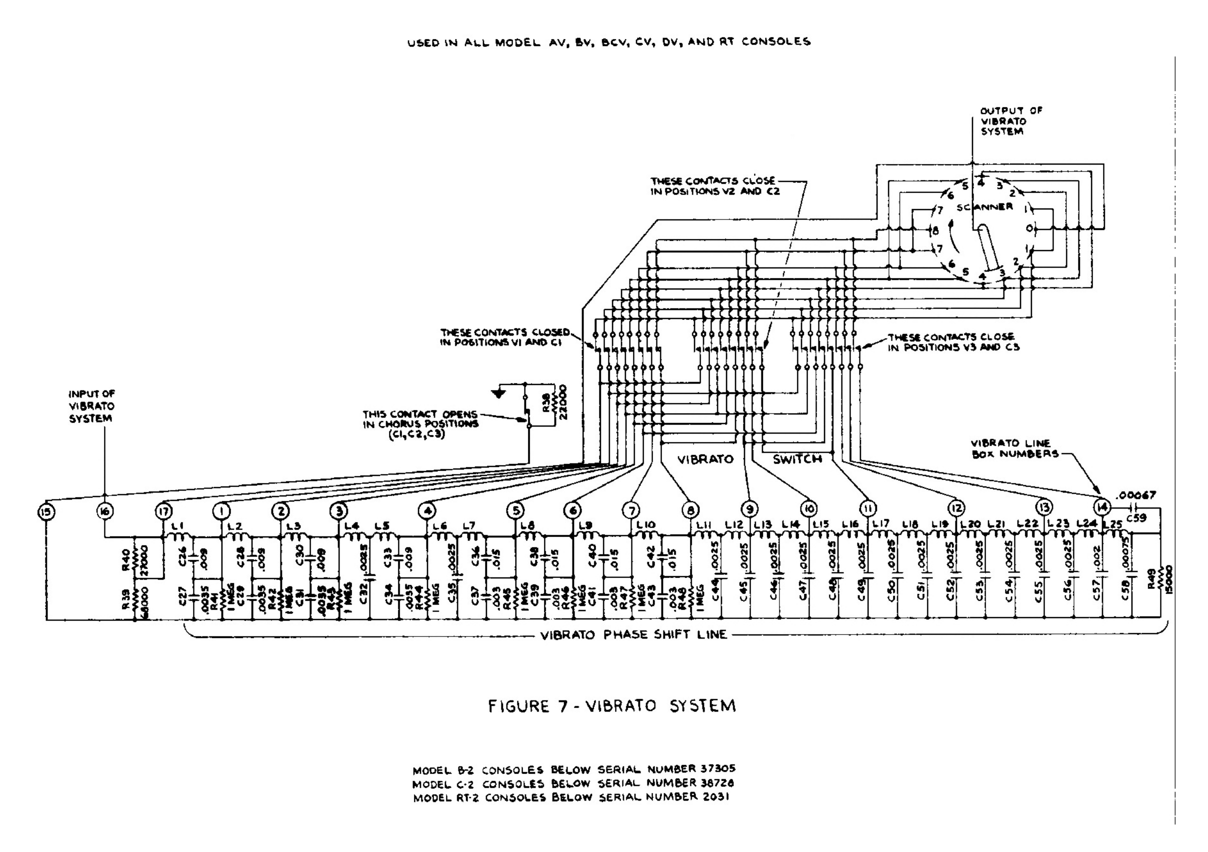


FIGURE 7 - VIBRATO SYSTEM

MODEL B-2 CONSOLES BELOW SERIAL NUMBER 37305
MODEL C-2 CONSOLES BELOW SERIAL NUMBER 38728
MODEL RT-2 CONSOLES BELOW SERIAL NUMBER 2031

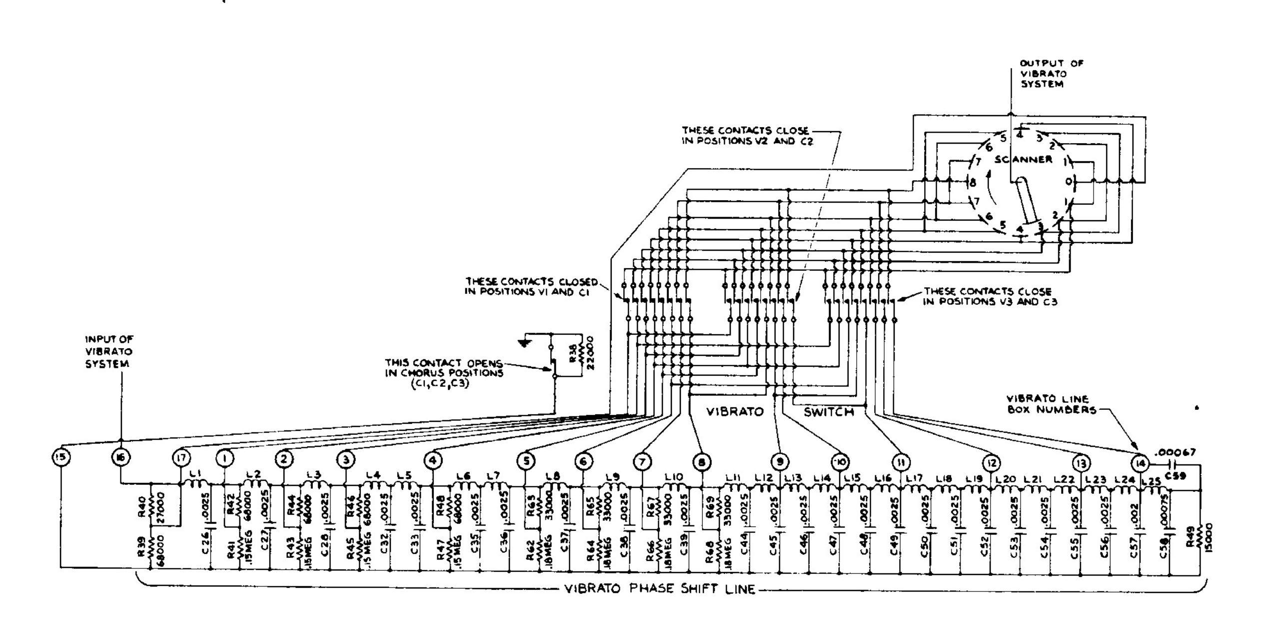


FIGURE 8 - VIBRATO SYSTEM

MODEL B-2 CONSOLES SERIAL NUMBER 37305 TO 45900, AND 46101 TO 46154
MODEL C-2 CONSOLES SERIAL NUMBER 38728 TO 46961
MODEL RT-2 CONSOLES SERIAL NUMBER 2031 TO 2735

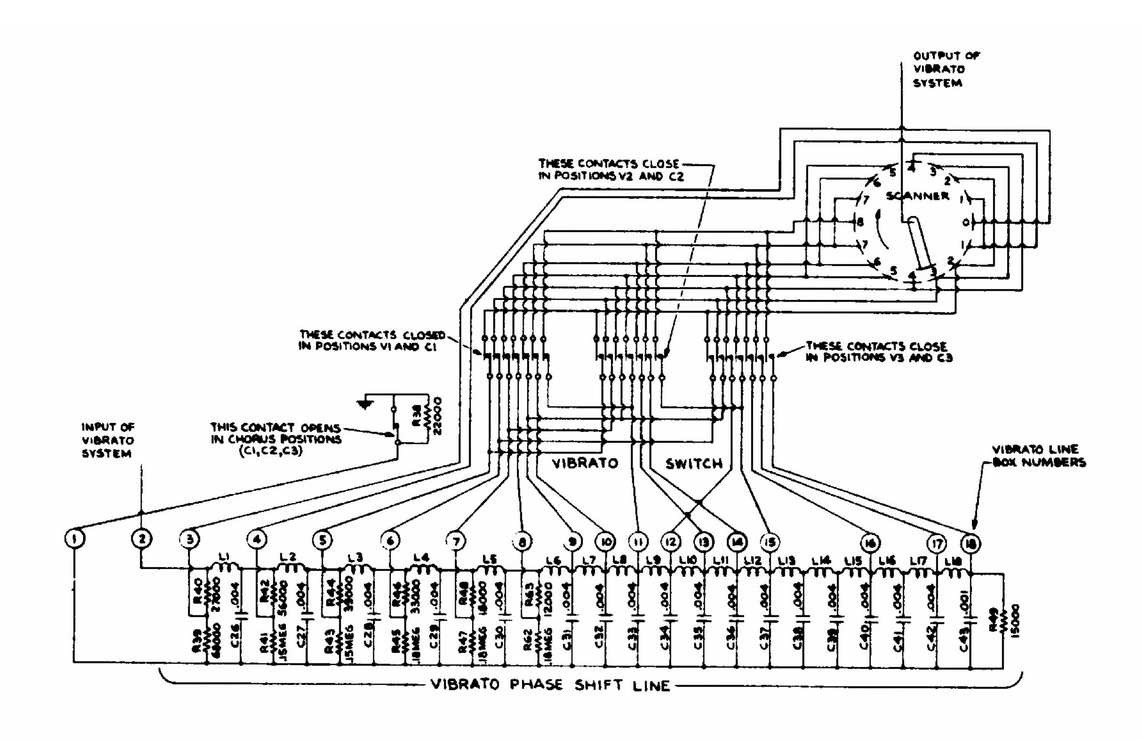


FIGURE 9 - VIBRATO SYSTEM

Model B-2 Serial # 45901 - 46100, and 46155 and above
Model C-2 Serial # 46962 and above
Model RT-2 Serial # 2736 and above
Models B-3 and C-3 Serial # 56000 and above
Model RT-3 Serial # 4000 and above
Model A-100 and D-100 all

THE HAMMOND ORGAN WITH PERCUSSION

Percussion tones are available only on the upper manual (with the B adjust key depressed) of all consoles with the suffix -3 in their model designation. These consoles, except for the four percussion control tablets in the upper right hand corner, look and function similar to consoles with the suffix -2 in their model designation, when the percussion effect is not in use.

1. THEORY OF OPERATION

The percussion tones are produced by borrowing the 2nd or 3rd harmonic signal from the corresponding drawbar (of the upper manual B adjust key drawbar group), amplifying it, returning part of it to same drawbar, and conducting the balance through push-pull control tubes, which when keyed cause the signal to fade away at a pre-determined rate.

2. GENERAL CICUIT OPERATION (All Reference Is To Figure 24 Section 16, Part 1)

With percussion tablet on, upper manual B adjust key and an upper manual playing key pressed, the 2nd or 3rd harmonic signal appearing on an upper manual busbar is conducted through B adjust key drawbar wire to input of percussion amplifier (terminal H) and amplified by T4 and V5. Besides providing push-pull signal for the control tube V7, the percussion input transformer T5 has a third winding which feeds the signal back to the 2nd or 3rd harmonic drawbar through equivalent key circuit resistor R50 and terminal J. Thus the signal that was borrowed from the 2nd or 3rd harmonic drawbar for the percussion amplifier is replaced.

When a key is depressed the signal first sounds loudly through the control tube, transformer T6, a high pass filter, and terminal D to the grid of V4. Immediately condenser C31 in the control tube grid circuit begins to discharge, causing the signal to fade away. Terminal K (approximately +25 volts) is connected to the 8th harmonic B adjust key drawbar wire which is connected to manual busbar. When an upper manual key is pressed, terminal K is grounded through the tone generator filters. This virtually grounds the plate of V6 (connected as a diode), stops conduction, and isolates cathode and control tube grid circuit. The grid then drifts from approximately +25 volts to about +15 volts, at a rate determined by the time required for C31 to discharge through R57 and R58. At the completion of this sequence the percussion signal is blocked. No further percussion effects occur until all keys of the upper manual are released and control grids can again rise to +25 volts. The rate of this rise is fixed by the time required to charge C31 to +25 volts through R55 and R56.

3. FOUR PERCUSSION CONTROL TABLETS, CUTOFF CONTROL, AND THEIR FUNCTIONS

The Percussion On-Off Tablet when turned on does five things to the signals of the upper manual B adjust key drawbars.

(a) It disconnects the 2nd harmonic drawbar from its signal wire.
(b) It disconnects the 3rd harmonic drawbar from its signal wire.
(c) It connects the 2nd or 3rd harmonic drawbar signal wire (depending on position of Harmonic Selector Tablet) to input of percussion amplifier.
(d) It disconnects the 8th harmonic drawbar from its signal wire. This wire (connected through generator filters to ground when any key is pressed) is connected to terminal K. The 8th harmonic signal is not available on the upper manual as long as percussion tablet is on.

(e) It inserts resistor RI in series with upper manual matching transformer (T2) secondary to reduce upper manual organ signal so that lower manual will musically balance with the combined upper manual organ and percussion signals.

The Preset Percussion Switch is not part of the control tablet assembly or percussion on-off tablet, but functions as an interlock with it. It is located under the upper manual B adjust key. This switch insures that the full upper manual signal is restored by shorting out series resistor R1 introduced by the percussion on tablet when any other upper manual preset or adjust key is pressed. The Volume Tablet in soft position shunts resistor R46 across the percussion output transformer, reducing percussion signal, and also shorts out upper manual matching transformer compensating resistor RI thus restoring upper manual signal strength to provide proper balance between the manuals.

The Decay Tablet in fast position shunts resistor R57 across the slow decay resistor (R58) reducing time for decay capacitor C31 to discharge and for V7 control grids to reach cut-off. Also to preserve the same effective loudness in fast decay position as in slow decay the control tube bias is reduced by disconnecting R59 and allowing control tube grids to become more positive which increases output signal about 50%.

The Harmonic Selector Tablet does three things to the signals of the upper manual B adjust key drawbar group:

In Second Position:
(a) It connects the 2nd harmonic signal wire to percussion amplifier input.
(b) It connects the 3rd harmonic signal wire to the 3rd harmonic drawbar.
(c) It connects the signal from terminal J to 2nd harmonic drawbar.

In Third Position:
(a) It connects the 3rd harmonic signal wire to the percussion amplifier input.
(b) It connects the 2nd harmonic signal to the 2nd harmonic drawbar.
(c) It connects the signal from terminal J to 3rd harmonic drawbar.

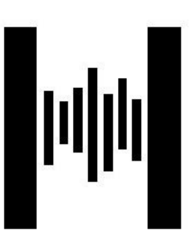
The Percussion Cut-off Control which is located on the amplifier should be re-adjusted as follows whenever control tube V7 is replaced:

Set expression pedal wide open, both volume tablets normal, percussion on, percussion decay fast, and harmonic selector in either position. Depress any key in upper half of upper manual and then adjust cut-off control exactly to the point where signal becomes inaudible.

THE HAMMOND ORGAN

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AMPLIFICATION



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THE AMPLIFICATION SYSTEM

The electrical impulses which produce the tones of the Hammond Organ are given their original amplification by a preamplifier located in the console, and are then transmitted to the power amplifiers which are located in the tone cabinets. It will be noted that no power transformer is included in the preamplifiers shown in figures 1 through 9, the required plate current being supplied by the power amplifier in the first tone cabinet. Later models of preamplifiers have a complete power supply incorporated within them.

A tone control is included in all preamplifiers whereby the relative intensity of the high and low frequencies may be changed to suit acoustical conditions by varying the amplitude of the higher frequencies. On tremulant equipped consoles this control will be found under a screw cap located toward the right end of the chassis, while on consoles equipped with the Hammond Vibrato this tone control will be found under the cap marked HI IMP INPUT. Selective vibrato consoles have the tone control located midway on the preamplifier chassis.

A microphone or phonograph pickup may be used with the organ if special circumstances make it desirable. On tremulant type consoles the input terminal, marked P on the preamplifier, goes through a screen bypass condenser to the screen of the input tube. This terminal is normally grounded, and the input device should have an impedance of 500 ohms or less in order not to reduce the volume of the organ. A signal level of a volt or more is required to drive this point, and therefore it is suggested that the microphone or phonograph be connected through a suitable preamplifier having an output impedance of about 200 ohms.

On vibrato consoles the input terminal, located under the cap marked HI IMP INPUT on the preamplifier, goes to the grid of one input tube. This circuit has an input of 1 megohm impedance and requires an input signal of about 60 millivolts maximum.

Most preamplifiers used on selective vibrato type consoles are equipped with a standard phonograph input jack. The input impedance is approximately 1 megohm and the circuit requires a maximum input signal of about ½ volt.

The push-pull signal line from the preamplifier output transformer to the tone cabinets has a total impedance of approximately 200 ohms. As it is connected directly to the grids of the power amplifier input tubes, practically any number of power amplifiers may be connected in parallel.

The section on cables and plugs shows methods of connecting amplifiers to the console.

When making tube replacement, output tubes in the amplifier should be checked for similar plate current readings. If tubes have been in service for a considerable length of time it is usually advisable to change all tubes at one time rather than to try to match new tubes to the old ones.

PREAMPLIFIER ANALYSIS FOR CONSOLES PRIOR TO USE OF THE AO-10

It is suggested that amplifiers used in the Hammond Organ be tested with a conventional radio set analyzer with AC and DC voltage ranges up to 500 volts, and current ranges up to 100 milliamperes. With this flexibility the instrument may also be used as a tube tester and a line voltmeter. A resistance scale on the analyzer meter or a separate meter with self-contained battery is useful for testing resistors in the amplifiers. It should have a scale reading up to 3 megohms.

Typical readings for an analyzer with a 1000 Ohms per Volt meter are given below. The voltages may vary slightly if readings are taken with a meter of different sensitivity or with ranges in variance with those specified.

Weston Model 772 type 2 analyzer is satisfactory for all necessary tests of the organ, and when combined with a tube checker in Weston's Model 775 it is a complete portable service set adequate for the Hammond technician.

POWER AMPLIFIER

Tube	Filament volts	Plate volts	Grid volts	Plate current
56	2.5 V. AC	140 (250 V. scale)	10 (50 V. scale)	2 ma.
2A3	2.5 V. AC	320	50 (50 V. scale)	35-40 ma.
5Z3	5 V. AC	450 V. AC	-	-

PREAMPLIFIER

Tube	Filament volts	Plate volts	Grid volts	Plate current
56	2.5 V. AC	250 (250 V. scale)	9 (50 V. scale)	4 ma.
57	2.5 V. AC	50 (250 V. scale)	2 (50 V. scale)	0.5 ma.

Screen volts (57 tube) - 35 (50 volt scale)

If a discrepancy of 20% or more is noticed on any of the above readings, an investigation should be made of all parts which might affect it. Any resistor differlng by as much as 30% from its rated value should be replaced. A condenser should be replaced if its capacity has dropped as much as 20%.

For testing both generator and ampllfler condensers, a neon lamp type tester is very satisfactory. Such a tester should be capable of checklng both electrolytic and paper condensers of capacities ranging from .001 to 30 microfarads. In every case, condensers must be disconnected before testlng, otherwise the readlng will be affected by other parts of the circuit.

All resistors are marked w1th the standard RMA color code. The colors represent numbers as follows:

0- black	5- green
1- brown	6- blue
2- red	7- violet
3- orange	8- grey
4- yellow	9- white

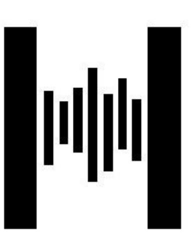
The body color of the resistor is the first digit of its resistance value; the end color is the second digit; and the dot or center band represents the number of ciphers after the first two digits. If no dot or center band can be seen, then it is the same as the body color. For instance, the resistance for a red body, green end and orange dot or center band would be all follows: first digit 2,second digit 5, followed by three ciphers: thus, 25,000 ohms.

Chokes and audio transformers may be tested by reference to their direct current resistances given with the circuit diagrams. If a winding is broken, the resistance will be infinite, and a short circuit will be indicated by greatly reduced resistance. The power transformer and filament transformer may be checked by comparing their voltages with those given on the diagrams. It should be remembered that all given voltages are for 115 volt A.C. line and for any reduction in line voltages they will be correspondingly affected.

THE HAMMOND ORGAN

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REVERBERATION



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REVERBERATION CONTROL

Reverberation control is an important feature of any Hammond Organ installation. This device is enjoying wide acceptance because it produces reverberation in variable degrees so the Hammond Organ. when installed in an acoustically dead enclosure, sounds very much like an organ played in a large acoustically live church or auditorium where organ music. enhanced by considerable reverberation sounds at its best.

Reverberation is the prolongation of sound by repeated reflections or echoes, and is measured by the time required for a sound to become inaudible after the source of sound has been stopped. It is present in some degrees in all enclosures, and music is more pleasing to the ear when accompanied by some amount of reverberation. This is particularly true of organ music.

Reverberation results from the fact that the longer path traveled by reflected sound causes a delay in hearing the reflected sound waves. This is easily realized in the case of sharp staccato sounds and a fairly distant reflecting surface, as the delayed sound is then heard separately from the direct sound and is recognized as an echo. When music is played in a large room however, the sound echoes and re-echoes repeatedly until absorbed by the surroundings. The Hammond reverberation control is an electro-mechanical device which introduces multiple echoes by means of reflections within a network of coil springs and thereby provides adequate reverberation in locations where the natural reverberation is not sufficient.

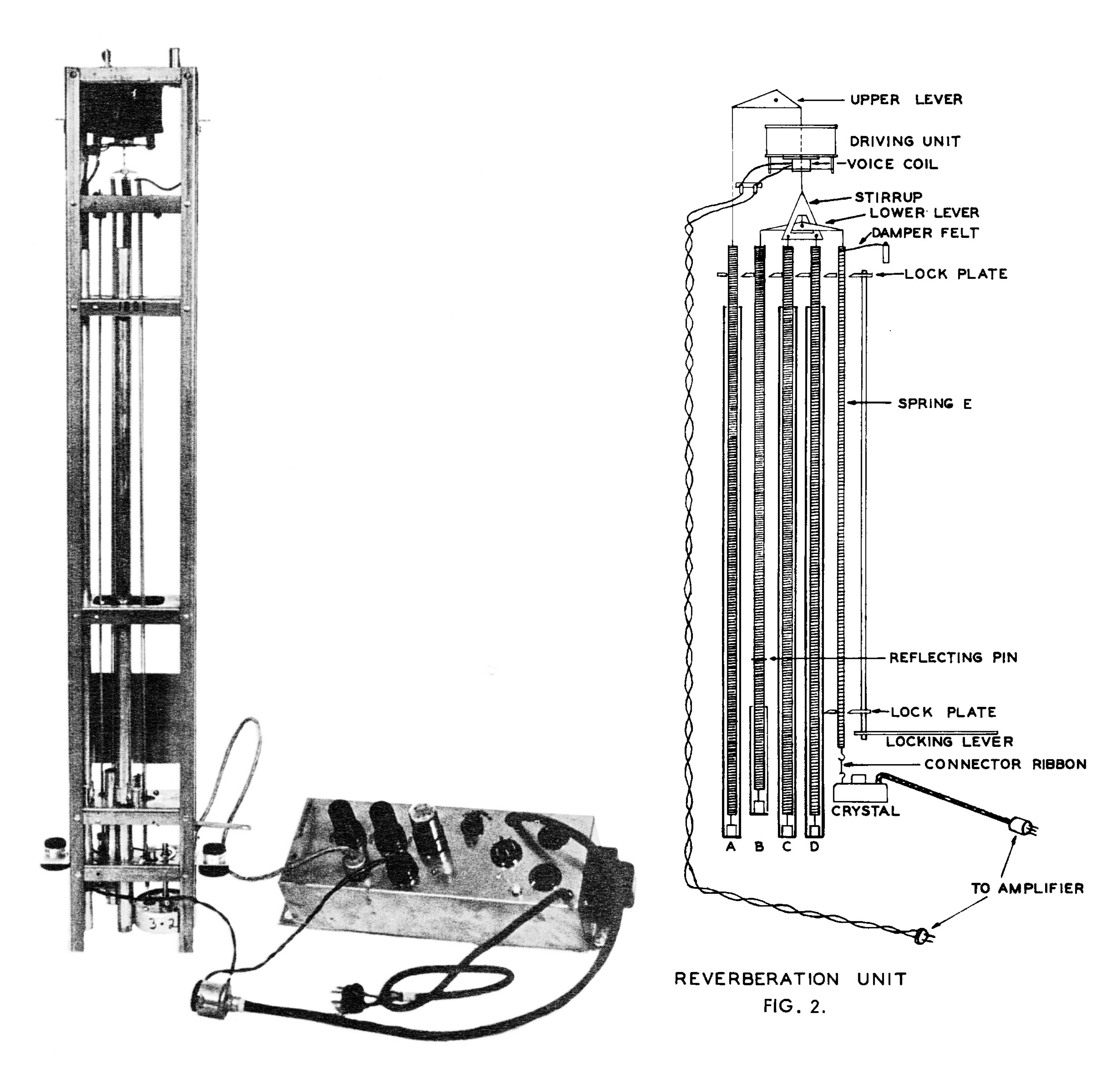
OPERATION OF FLUID TYPE

The fluid type reverberation unit (see figure 1), about 4 x 5 inches in cross section and about 4 feet high, is connected to a reverberation preamplifier built into the power amplifier. (In some models of tone cabinets the reverberation preamplifier is a separate unit connected to the power amplifier by cables.) The entire equipment is attached to the organ tone cabinet.

Reverberation is applied to the organ music after it leaves the console. Part of the console signal goes directly to the power amplifier and part goes into the reverberation channel, after suitable amplification.

The electrical signal fed into the reverberation unit is converted into mechanical energy by a moving coil driver unit, similar to a dynamic speaker without a cone. The mechanical waves are transmitted through coil springs, which have the property of conducting sound vibrations much more slowly then the speed of sound waves in air. In this way a spring of convenient length can introduce a delay equivalent to that obtained in a large hall.

The driver unit, at the top of figure 2, introduces up-and-down vibrations into the stirrup directly under it. The two enclosed springs under the stirrup hold it in position but permit it to move freely up and down, and the spring at the far left balances the pull of the others. These three springs are almost entirely immersed in damping fluid, as they act largely as dampers to stabilize the response of the driver and prevent undesired reflections.



REVERBERATION UNIT
FIG. 2.

Figure 1

A sound wave from the stirrup travels down the open spring at the far right to the crystal pickup, where an electrical signal is produced and conducted to the power amplifier. This is the first reflected signal, delayed about 1/15 second from the part of the original signal which went directly to the power amplifier.

The same wave from the stirrup also travels down the second spring from the left, which enters the short damping tube. At the bottom of this spring the wave is reflected back along the spring, reduced in intensity by the damping action of the fluid. At the stirrup the horizontal lever transfers the wave to the right-hand spring, and it goes on to the crystal to produce a second reflected signal about 3/15 second after the direct signal.

Very little of the energy of each wave is absorbed by the crystal, and the rest is reflected back along the spring. The first reflected signal traverses the right spring, is transferred by the lever, and goes down the spring to the short damping tube.

Here it is reflected in reduced intensity, retraces the same path to the crystal, and produces a third reflected signal about 5 /15 second after the direct signal. The second reflected signal is similarly repeated, and this process continues over and over, giving a series of signals about 2/15 second apart, until the vibration is dissipated by fluid friction in the short tube. Just above the short damping tube a reflecting pin attached to the spring causes partial reflection of high frequencies and helps to make the overall response more uniform.

The damper felt avoids undesirable transverse vibration of the springs.

A greater amount of fluid in the short tube will cause increased energy loss at each reflection and thereby reduce the number of audible reflections. Adjusting the level of fluid in this tube, therefore, changes the reverberation time and simulates enclosures of different sizes.

A reverberation selector switch in the amplifier circuit following the crystal can be adjusted to pass more or less of the reflected signal in proportion to the direct signal. While this does not actually change the reverberation time, it is a convenient way to change the amount of reverberation instantly. Generally, therefore, the fluid level in the short tube is left constant, at the position recommended on the tone cabinet instruction card, and the switch is used to select the best amount of reverberation for each installation.

The photograph of the reverberation unit (figure 1) shows a reverberation preamplifier of the type used in kits for installation in some non-reverberation tone cabinets. In later reverberation type tone cabinets the power amplifier is wired so that this preamplifier is unnecessary.

Amplifier circuits associated with the reverberation unit are shown in the section containing amplifier diagrams.

INSTALLATION OF FLUID TYPE

In installations of tone cabinets using type F, type G, and type H power amplifiers, only a single reverberation unit is necessary for any installation, regardless of the number of tone cabinets used. The reverberation unit is connected to the first power amplifier (the one to which the console cable connects) and the reverberated signal is supplied from that amplifier to additional cabinets.

An exception occurs in the case of type HR-40, KR-40 and JR-20 tone cabinets, in which no reverberated signal is available for additional cabinets (because of the separate bass and treble channels). If reverberation is desired on several H, J, or K series cabinets, each must be equipped with a reverberation unit.

When two or more types of cabinets are used in any installation, it is preferable that any H or K series cabinets be connected to the console ahead of any cabinets having type F, type G. or type H amplifiers in order that reverberated signals may not enter the bass amplifier channel. Otherwise there may be objectionable irregularities in the response of the lower pedal notes. Further information on the use of reverberation may be found in the section covering Acoustics.

FILLING AND ADJUSTMENT OF FLUID LEVEL

When installing a reverberation unit or tone cabinet, the damping fluid (furnished in bottles with the unit) should be added with care, following directions on the tone cabinet instruction card. The level in the three long tubes is not critical; for best damping it should be near the top. but not high enough to spill if the unit is moved. Enough fluid is furnished to fill each tube to about one inch from the top.

The short tube should be filled to exactly 3 -1/4 inches from the top, using the special suction bulb supplied. This amount of fluid gives the best reverberation effect for average conditions.

If acoustic conditions are very unusual, or if an organist has a definite preference for greater or less reverberation, the level in the short tube may be set higher or lower. Lower fluid level will give longer reverberation time and higher fluid level will give shorter time. There is a temperature effect due to change in viscosity of the fluid (lower temperatures will shorten the reverberation time and higher temperatures will lengthen it) but no adjustment for this effect is necessary unless the temperature is consistently below 50 degrees F or above 95 degrees F.

The reverberation selector switches are set at HI when leaving the factory. and should be readjusted on installation to give the most desirable reverberation effect. If there is any uncertainty as to the proper adjustment, it is generally preferable to allow too much reverberation rather than too little.

OPERATIONAL ADJUSTMENTS OF FLUID TYPE

It is a well known acoustical phenomenon that audibility of some frequencies is emphasized over others in any given enclosure. Range of frequencies affected depends upon the size and type of reflecting surfaces such as walls and ceilings. Thus if a musical instrument such as an organ is played in an enclosure of almost any size, some frequencies will sound louder in one portion of the listener area than in another, and conversely some frequencies will sound weak. This can be effectively demonstrated by playing the organ in a small room with a microphone, then listening to the signal picked up by the microphone in another room. Variations in loudness will be startling especially when single frequencies are sounded.

The reverberation unit similarly produces a response pattern which tends to emphasize some frequencies over others to a slight degree. This is an operating phenomenon of the equipment and cannot be eliminated. This room pattern effect has not proved seriously objectionable, because as described above it stimulates an acoustical effect which is present in some degree whenever any musical instrument producing a wide range of frequencies is played in an enclosure.

If some notes on the organ sound excessively loud while others sound weak it may be traceable to the reverberation control system. In investigating this, disconnect the reverberation system by turning the switch on the reverberation preamplifier or amplifier to the off position. 1£ notes then sound at equal loudness, turn reverberation system on again and make the following adjustments:

1. The two-pole plug, which is connected to wire carrying signal to the driving unit at the top of the reverberation unit, may be inserted in two positions. Reversing this plug by turning it at 90 degrees will reverse the input signal phase, thus changing the response pattern of the reverberation system. Reversing this plug will often improve evenness of overall frequency response for a given installation.

2. Sometimes evenness of frequency response can be improved by cutting down amplitude of the reverberated signal. This is accomplished by changing the position of the reverberation switch. If switch is on HI move it to Med, and if switch is on Med move it to Lo.

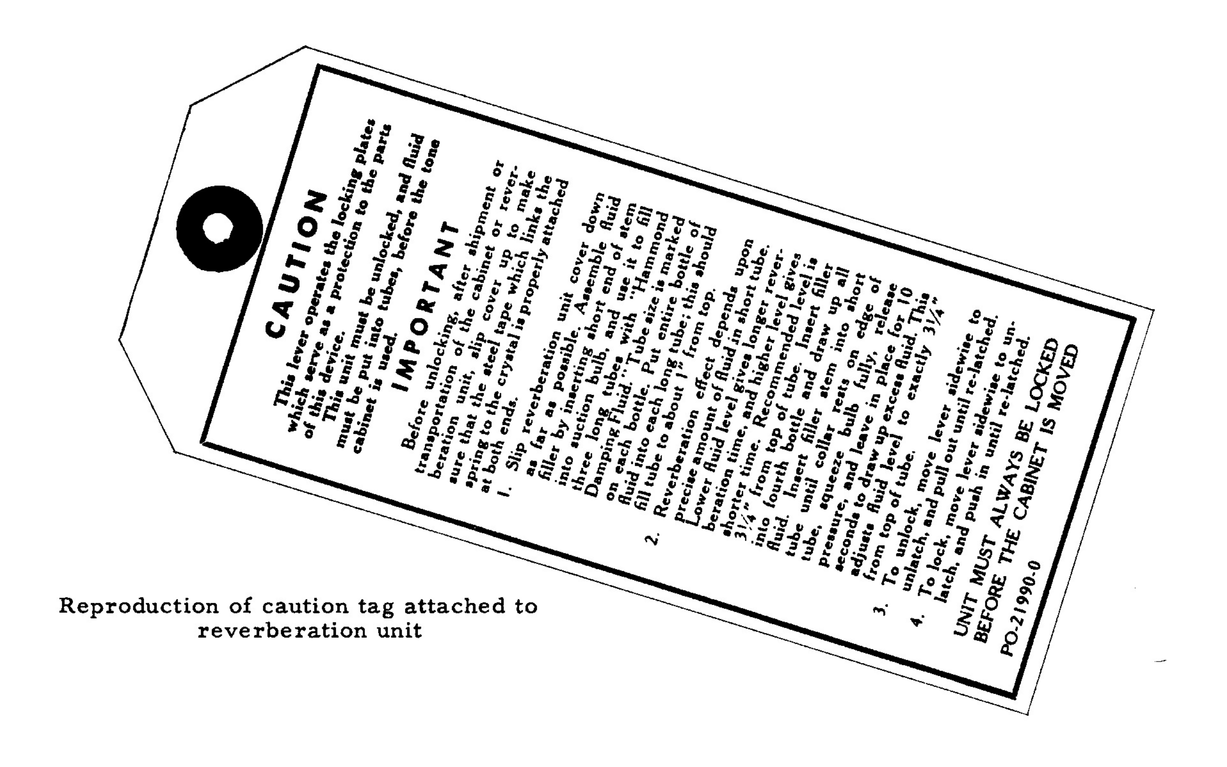
Exact recommendation on adjustment of this switch is somewhat difficult as the purpose of the reverberation control is to compensate for lack of natural reverberation. Adjustment of it therefore should be made in cooperation with the organist, who must understand its intent. In large installations the use of two reverberation units will reduce room pattern to the point where it is negligible.

MOVING THE FLUID TYPE

The reverberation unit appears to be a delicate device but when once set up it is very dependable and requires no further attention. When a tone cabinet is moved even a few feet, however, the reverberation unit must be locked to avoid excessive vibration of the springs. If the cabinet is to be tilted, the unit must be removed, to avoid spilling the fluid, and replaced after moving. If the unit itself cannot be kept upright while moving, the fluid must be drained and later replaced. Hammond damping fluid is a grade especially selected for this purpose, and no other kind should be used.

Failure to lock the unit when moving usually necessitates replacement of the complete driver assembly or the upper or lower lever assemblies which are a part of it. When parts are replaced, the springs must be balanced as follows:

In a complete driver assembly ordered for replacement, the wire passing through the unit from the upper lever to the stirrup is not soldered. It should be left unsoldered until this adjustment is made. Replace the driver assembly and attach all the springs; check and adjust the single damping tube, if necessary, to make the upper lever assembly level. Then solder the wire to the small tube passing through the voice coil. When only the upper or lower lever assembly is replaced, the wire need not be unsoldered, but the upper level must be made level by adjusting the single tube.


CAUTION

This lever operates the locking plates which serve as a protection to the parts of this device.

This unit must be unlocked, and fluid must be put into tubes, before the tone cabinet is used.

IMPORTANT

Before unlocking, after shipment or transportation of the cabinet or reverberation unit, slip cover up to make sure that the steel tape which links the spring to the crystal is properly attached at both ends.

1. Slip reverberation unit cover down as far as possible. Assemble fluid filler by inserting short end of stem into suction bulb, and use it to fill three long tubes with "Hammond Damping Fluid." Tube size is marked on each bottle. Put entire bottle of fluid into each long tube; this should fill tube to about 1" from top.
2. Reverberation effect depends upon precise amount of fluid in short tube. Lower fluid level gives longer reverberation time, and higher level gives shorter time. Recommended level is 3¼" from top of tube. Insert filler into fourth bottle and draw up all fluid. Insert filler stem into short tube until collar rests on edge of tube, squeeze bulb fully, release pressure, and leave in place for 10 seconds to draw up excess fluid. This adjusts fluid level to exactly 3¼" from top of tube.
3. To unlock, move lever sidewise to unlatch, and pull out until re-latched.
4. To lock, move lever sidewise to unlatch, and push in until re-latched.

UNIT MUST ALWAYS BE LOCKED BEFORE THE CABINET IS MOVED

PO-21990-0

Reproduction of caution tag attached to reverberation unit

OPERATION OF DRY TYPE

A later reverberation device. Figure 3. is an improved unit which employs a dry damping means instead of the liquid previously used. It has improved driver and pickup elements and has three transmission springs instead of the one formerly used.

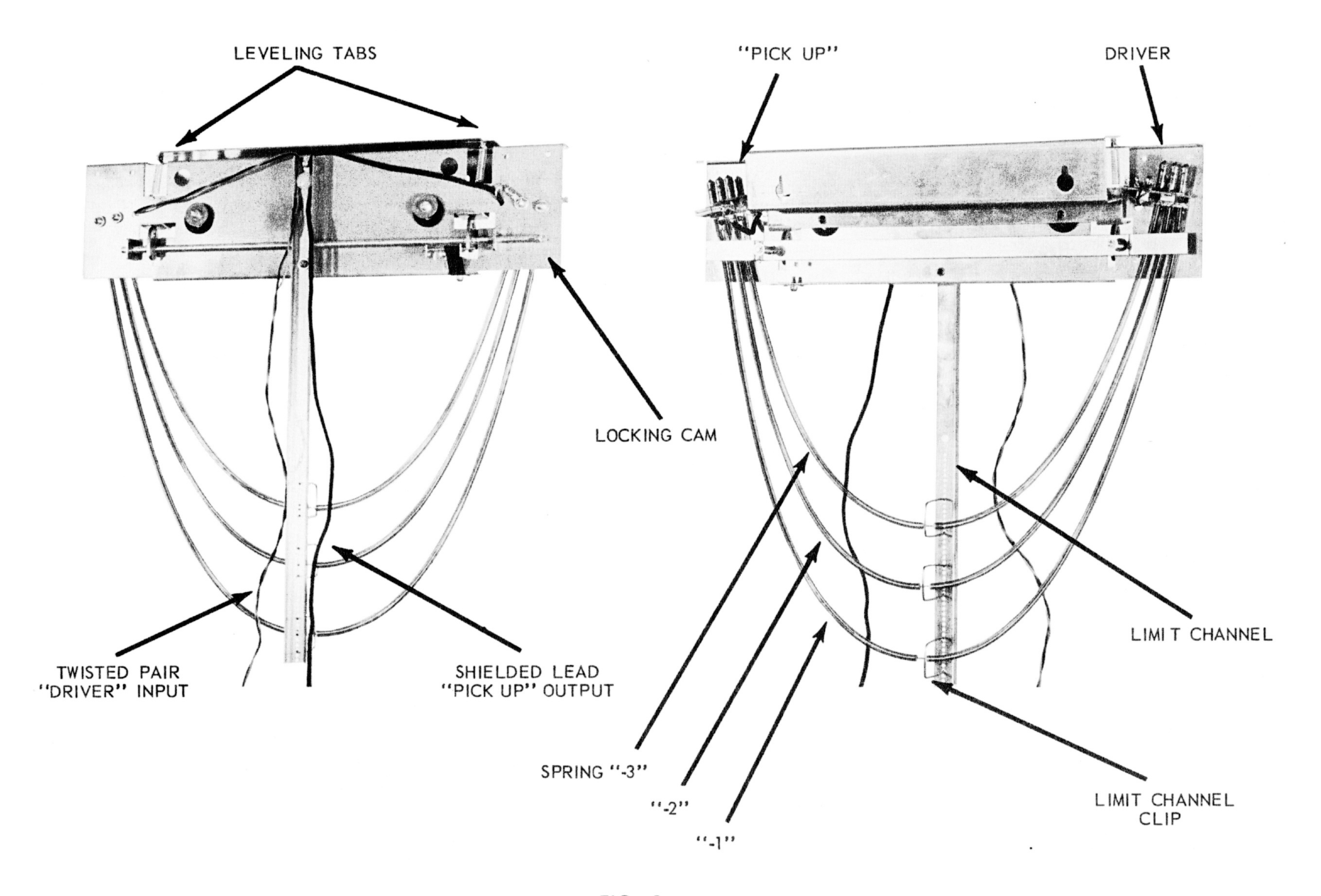
The device is about fourteen inches high. thirteen inches wide and two inches in depth. It is incorporated in the new PR-20. PR-40 and QR-40 tone cabinets.

In operation. an electrical signal from an amplifier is applied to the driver unit in the reverberation device which then converts the electrical signal into mechanical energy which is fed into the three springs of different lengths. The signal takes 1/22 second to traverse the shortest spring to the pickup, which reconverts part of the energy to an electrical signal and reflects most of the energy back along the spring to the driver, where again most of the signal is reflected back along the spring to the pickup. This transaction continues until the signal energy at the pickup is reduced to one millionth of its original value. This period is about two seconds in duration. The other two springs operate in a similar fashion. but their reflections occur at longer time intervals, 1/17 and 1/15 second respectively. The amount of damping for each of the three springs is so proportioned that they have a uniform decay rate.

OPERATION IN PR AND QR SERIES TONE CABINETS

The dry type reverberation device mounted in the PR and OR series tone cabinet functions as follows. Part of the console signal is applied to the reverberation driver and the resultant reverberated signal at the pickup is separated into two frequency bands, one occupying the spectrum from thirty-two to two hundred cycles, and the other from two hundred cycles to six thousand cycles. The low frequency reverberated signals are mixed with the direct console signals. amplified and fed to the low frequency speakers. The high frequency or treble reverberated signals are amplified and fed to a separate speaker system, while the treble signals from the console are also amplified and fed into another speaker system. In other words, the low frequency direct and reverberated signals are electrically mixed and the high frequency direct and reverberated signals are acoustically mixed.

Two selector switches are mounted on the side of the PR and OR series tone cabinets to provide a variation in the amount of reverberation produced. The bass reverberation switch provides increased direct output as the amount of reverberated signal is reduced. This is accomplished by introducing more or less direct signal into the bass channel as the amount of reverberation is decreased or increased. The treble reverberation switch controls the gain of the treble reverberation amplifier channel, but if the switch is turned to the Reverberation Off position, the direct console treble signal is fed into this channel to provide full treble acoustic output from the cabinets.



LEVELING TABS
"PICK UP"
DRIVER
LOCKING CAM
LIMIT CHANNEL
TWISTED PAIR "DRIVER" INPUT
SHIELDED LEAD "PICK UP" OUTPUT
SPRING "-3"
"-2"
"-1"
LIMIT CHANNEL CLIP

FIG. 3

INSTALLATION OF PR AND QR TONE CABINETS

When these tone cabinets are installed the Room Size control on the rear of the amplifier chassis should be adjusted in accordance with the instruction card in the tone cabinet, and the reverberation device should be unlocked. Warning: Whenever the cabinet is moved, even one or two feet, the reverberation device should be locked. Failure to do this may cause one or more springs to become unhooked from the driver or pickup assembly.

Tone cabinets embodying this reverberation unit do not provide a reverberated signal to other tone cabinets. If more than one tone cabinet of the type normally embodying this unit is used and reverberation is desired from all tone cabinets, then a reverberation unit must be included in each tone cabinet.

Kits are available which will permit turning the reverberation on and off from the console without the use of additional cables. Several different kits are available, depending upon the type of console , and the instruction sheet accompanying each kit describes the installation and operation. These kits are designed for use with PR and QR series cabinets only.

SERVICE SUGGESTIONS

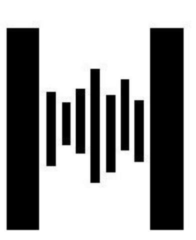
Should no reverberation be evident in playing a tone cabinet equipped with this device, but a loud noise results from touching the springs, it is quite likely that the locking device has not been completely opened. Make sure that the springs of the unit are free of the clamps, which are located near the driver and pickup.

If in moving a tone cabinet a spring is disengaged from the driver or pickup, the ends can again be reinserted in the loops. For proper operation it is suggested that the reverberation unit be removed for this operation and the loose springs be allowed to hang quietly, then the end should be picked up and inserted in the loop from which it became disengaged. The purpose of this procedure is to eliminate any twist within the spring which could cause erratic noises in operation because of torque which would be transferred to the pickup portion.

THE HAMMOND ORGAN

– 13 –

PEDAL SOLO UNIT



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

CONCERT MODEL CONSOLES

(Pedal Solo schematics referenced here
will be found in the Wiring Diagrams and Schematics section.
Block diagrams can be found in General Descriptions)

The Model RT Hammond Organ console is similar electrically to the Model CV console, but differs in the following respects:
1. The console woodwork is larger and somewhat different in depth.
2. The pedal keyboard is concave, with 32 pedal keys.
3. The pedal solo unit is added to provide deep and rich pedal tones desired by the concert organist.

The Model RT-2 console includes the above feature and also has the selective vibrato system as used in Model C-2.

The Model RT-3 console is similar to Model RT-2 with the addition of the percussion feature.

The Model D-100 console is similar to Model RT -3 with the addition of a built in power amplifier and speakers.

PEDAL SOLO UNIT

The pedal solo unit incorporated in these consoles provides a series of bright pedal solo tones in addition to the usual pedal accompaniment tones available on other models. The pedal solo tones, generated by a vacuum tube oscillator circuit, are controlled by a volume control knob and eight tilting stop tablets, of which one turns all the pedal solo tones on or off and the others provide various pitch registers and tone colors. The pedal solo unit is independent of the electromagnetic tone wheel generator and can be turned off without affecting the remainder of the organ.

Only one pedal solo note will play at a time (if two pedals are depressed at a time, only the higher one plays) but this does not affect the foundation or accompaniment tone controlled by the two pedal drawbars. It is possible therefore, for the left foot to play a bass accompaniment note set up on the pedal drawbars. while at the same time the right foot plays a pedal solo note (the accompaniment tone on this higher note being masked by the high solo quality).

The pedal solo unit is designed as a part of these consoles. and because of mechanical limitations it is not adaptable to any other model.

NOTE: Pedal solo generators of all types have slightly different electrical circuits but are interchangeable in all RT & D-100 series consoles. Type RTA was used in all Model RT and some Model RT-2 consoles. Types RTB and RTC were originally used only in Model RT-2. Types RTD and RTE have improved components - but no change in circuits.

HOW THE PEDAL SOLO UNIT WORKS

All notes of the pedal solo unit are controlled by a two-triode vacuum tube master oscillator circuit operating at audio frequencies from 523 to 3136 cycles per second, corresponding to 1 foot pitch. Thus the master oscillator operates over the full pedal keyboard range of 32 notes. Each time a pedal is depressed. its tuning contact tunes the oscillator to the pitch associated with the corresponding key in this 32 note range.

The output of the oscillator is fed into a series of five cascaded frequency dividers, each of which divides its input frequency by two and thus produces a note an octave lower than its input frequency. The five dividers thereby provide pitches of one, two, three, four, and five octaves below the pitch of the oscillator. In this way, when the oscillator is tuned to some given note, each divider produces a note in exact octave relation to the oscillator, thus forming a series of six notes having exact octave relationships. The particular frequency divider or dividers selected for sounding through the amplifier and speaker system of the organ will depend upon which of the stop tablets are used.

A control contact Under each pedal causes the control tube to transmit the signal to the amplification system with a controlled rate of attack.

COMPONENTS OF THE PEDAL SOLO UNIT

Electrically the pedal solo unit is very similar in principle to the Hammond Solovox Model L, although there are, of course, many differences. It employs tuning coils, tuning adjustment knobs, a master oscillator, and frequency dividers similar to those in the Solovox, and the stop tablets are similar in function to the register controls of the Solovox.

The Pedal Solo Generator is a chassis which looks like an amplifier and contains the master oscillator, five frequency dividers, an amplifier, a control tube, and a power supply. It is located directly above the pedal switch assembly, near the left side of the console as viewed at the rear.

The Tuning Coil Assembly contains 32 adjustable inductance coils, which tune the master oscillator to the frequencies of the 32 pedal notes. It is mounted above the pedal switch assembly, near the right side of the console as viewed at the rear.

The Control Panel, with stop tablets and a volume control knob, is mounted at the right end lower manual.

The Pedal Switch has nine contacts under each pedal key. One is used for tuning the pedal solo unit, the second serves to key the amplifier and make the pedal solo note sound, and the other seven carry harmonics from the main (tone wheel) generator to the pedal drawbars as in the B and C series consoles.

WIRING DIAGRAMS

In studying the operation of the pedal solo unit, refer first to the block diagram (figure 1) and second to the more detailed schematic circuit (figure 2, 2B or 2C). The schematic diagram of the console, apart from the pedal solo unit, is the same as for the Model CV, C-2, or C-3 console, shown in Section 2. Actual connections between the pedal solo unit and other parts of the console are shown in the section containing the console wiring diagrams.

The Oscillator

The 32 coils which tune the audio frequency oscillator are shown in figure 2. When the lowest C note is played (this pedal has no tuning contact), all 32 coils are connected in series to form the tuning inductance of the oscillator. When any other pedal is depressed, its tuning contact shorts out some of these coils (making less total inductance) and thus tunes the oscillator to the higher pitch associated with that note. If two pedals are depressed at the same time only the higher pitched of the two will sound.

Frequency Dividers

Each divider includes three triodes. One acts as a driver and pulse rectifier, supplying sharp and narrow negative pulses to actuate a symmetrical feed-back tripping circuit comprising two triodes. Either one (but only one) of these two triodes can be conducting at a time, for by drawing plate current it holds the other in a cut-off condition.

Suppose, for example, that the first triode is conducting and the second is cut off. Now a negative input pulse impressed on the grids of both triodes will not affect the second one, which is already cut off, but will cut off the first. This produces a positive pulse at the plate of the first triode, which is applied to the grid of the second triode through its feedback connection. The second triode then suddenly conducts current, producing a negative pulse at its plate. This negative pulse, applied to the first triode grid through its feed-back connection, insures that the first triode remains cut off. The situation is now exactly reversed, with the first triode cut off and the second conducting.

The next input pulse will act on the second triode, cutting it off again and making the first conductive; and thus two input cycles are required to produce one output cycle. Each frequency divider circuit therefore divides its input frequency in half, producing an output signal one octave lower than the preceding divider. One triode plate of each divider stage furnishes a signal of rectangular wave shape to the following driver tube, and output signals are taken from the driver and divider plates as indicated in figures 2, 2-B and 2C.

This divider circuit is capable of operating satisfactorily with wide variations in voltage, input frequency, and values of components, and therefore is remarkably stable and requires no adjustments.

Stop Tablets
From the preceding, we see that whenever any one of the three G pedals, for instance, is depressed, the frequency dividers, together with the oscillator, provide a series of six G notes in exact octave relations. The particular divider whose output is to sound is selected by the stop tablets: 2'& 1',4', 8', 16',32' BOMBARDE and 32' BOURDON. Thus the stop tablets act as register controls to shift the pitch range of the pedal solo unit to five different positions. If two or more of these controls are turned on simultaneously, a composite tone will be heard, consisting of the output of several dividers simultaneously sounding in their octave relations. (A tablet is on when the white dot is visible.)

Note With Regard To The 32-foot Stops
In playing, care must be exercised by the organist in using the 32' BOURDON and 32' BOMBARDE pedal stops. They are useful in permitting the player to obtain deep bass notes in the second octave of pedals. As the player descends into the first octave of pedals, he will find that the B, A#, A, and G# pedals have a definite pitch like the higher pedals. However, below the G# pedal, it becomes difficult to ascribe a definite pitch to these 32-foot tones. When a 32-foot stop is registered in concert organ music, it will be found that the pedals required will rarely be lower than the G pedal in the first octave. Therefore, do not use the 32-foot pedal stops indiscriminately, for ordinary bass purposes where the 16-foot tone is desired. The 32' BOURDON stop produces an effect which is mostly felt as a very low bass undulation when playing low in the first octave of pedals. The 32' BOMBARDE is always used in conjunction with other higher pitched stops. When played by itself in the lower half of the lowest octave of pedals, the effect is of such low pitch as to be of little use musically.

MUTE
Pressing the mute tablet shunts a small condenser across the signal circuit to reduce the intensity of the higher frequencies. This is effective on all the pedal solo stops to make the tones more mellow.

PEDAL SOLO ON
This tablet, connected in series with the keying contacts in the pedal switch, turns on and off any solo combination set up on the other tablets. It may thus be used as a preset control for the pedal solo unit.

Volume Control
The volume knob on the control panel is used to balance the pedal solo tones with the rest of the organ. The overall volume of the entire organ, including the pedal solo unit, is controlled by the expression pedal.

Control Tube
The push-pull control tube, a double triode, is normally cut off by a large negative bias applied to its grid circuit. When any pedal is pressed its control contact grounds this bias circuit (if the PEDAL SOLO ON tablet is on),thereby removing the bias and causing the note to sound. A condenser and resistor, C81 and R112, make the tonal attack smooth. The control tube is connected to an output transformer whose secondary feeds the pedal solo signal through the volume control to the organ preset panel, where it is combined with the other tones of the organ.

Tuning

All notes of the pedal solo unit are simultaneously tuned by adjusting two tuning knobs located on the pedal solo generator. These change the frequency of the master oscillator by shunting small additional capacitors across the main tuning condenser.

To tune the pedal solo unit to the organ, proceed as follows:

(a) Press only the 4, MUTE, and PEDAL SOLO ON tablets and hold down the middle D# pedal. The pedal drawbars must be pushed in, and the vibrato should be off.

(b) Pull out only the first white drawbar for either manual and press the corresponding preset key. Hold down the D# key above the middle C, with the drawbar and the volume control knob set to give approximately equal volume.

(c) Set the fine tuning knob on the pedal solo generator to its center position and adjust the rough tuning knob to the point which brings the two notes most nearly in tune (slowest beat between them). Then adjust the fine tuning knob to make the beat as slow as possible. While it is generally not possible to tune exactly to zero beat, the accuracy of tuning provided will be found to be sufficient.

(d) The organist may prefer to have the pedal solo generator tuned slightly sharp to increase the chorus effect between it and the main tone generator. To tune it sharp, turn the fine tuning switch counterclockwise one step.

Note: Never tune on the lower pitch registers (especially the 32-foot range) where the pitch acuity of the ear is insufficient for accurate tuning. If the 4-foot stop is tuned as directed above, all other registers will be in tune because they are locked by the frequency dividers to exact octave intervals.

Wiring of Pedal Switch

The nine contacts of each pedal key make contact with nine busbars extending the length of the pedal switch assembly. One set of contacts and the corresponding busbar, used for tuning the pedal solo unit, are wired to a terminal panel on top of the pedal switch, where the tuning coil cable connects. The other eight sets of contacts are wired to the main tone generator as indicated in the pedal wiring chart in the section on manuals and pedals, although only seven sets are actually used to carry tones from the main generator to the pedal drawbars.

The contacts of one set (the one marked 12th harmonic in the wiring chart) are used as control contacts for keying the pedal solo unit. The fact that they are connected to ground through the pedal switch wiring and the tone generator wiring does not affect their use for this purpose, since the keying circuit impedance is high by comparison. The busbar for these contacts is wired to a terminal on top of the pedal switch to which the white keying wire from the pedal solo control panel connects. These contacts are wired to the main tone generator in the usual way in order that they may supply the 12th harmonic in case special circumstances make it desirable to omit the pedal solo unit. In this case a green wire from the pedal resistor panel on the manual assembly (it will be found wrapped around the pedal switch cable, is connected to the busbar terminal on top of the pedal switch (see appropriate figure in the section of wiring diagrams). The pedal tones will then be identical to those on the B and C series organs.

TUBE SOCKET VOLTAGES
For Pedal Generator Stamped "Type RTA"

For voltages of other models see corresponding schematic diagrams.

These readings are taken with a 1000-ohms-per-volt meter having three scales of 50, 250 and 1000 volts. All voltages are taken with 117 volt line, and deviations of as much as 20 per cent may be caused by line voltage variations. The "PEDAL SOLO ON" tablet must be "on", and other tablets may be either on or off. No pedal should be depressed unless specified. The negative lead of the voltmeter is connected to ground except as noted. See figure 5 for terminal locations.

Connect Positive Voltmeter lead to:	Meter should read (volts)	Meter Scale	This shows voltage of:
"+290"	290	1000	1st Filter Capacitor
"+270"	270	1000	2nd Filter Capacitor
"+120"	120	250	3rd Filter Capacitor
"+ 20"	20	50	Divider Bias
Ground (neg. to "-37")	37	50	Control Tube Bias Supply
Tube VI (term. #3)	190	1000	Master Oscillator Plate (1st section)
Tube VI (term. #8)	8.5	50	Master Oscillator Cathode (1st section)
Tube V2 (term. #2)	230	1000	Master Oscillator Plate (2nd section)
Tube V2 (term. #3)	3.5	50	Master Oscillator Cathode (2nd section)
Tube V2 (term. #5)	180	1000	Oscillator Rectifier Plate
Tube V2 (term. #6)	2	50	Oscillator Rectifier Cathode
Tube V3 (term. #2)	75	250	Driver Plate
Tube V3 (term. #5), V6 (term. #3), V8 (term. #2 & #5)	95	250	Driver Plates
Tube V4, V5, V7, V9, V10 (term. #2 and #5)	55 to 75	250	Divider Plates
Tube V12 (term. #3)	120	250	Preamplifier Plate
Tube V12 (term. #8)	4	50	Preamplifier Cathode
Tube V13 (term. #2 and #5)	120	250	Control Tube Plates

Connect Positive voltmeter Lead to:	Meter Should Read (volts)	Meter Scale	This shows Voltage of:
Same, any pedal pressed	105	250	Control Tube Plates
Tube V13 (term. #3)	0	50	Control Tube Cathode
Same, any pedal pressed	3	50	Control Tube Cathode
Tube V11 (term. #8)	290	1000	Rectifier Cathode

AC VOLTAGES

Heater voltage to all tubes except V11		6 V. RMS
Rectifier tube V11 heater voltage		5 V. RMS
V11 term. #4 or #6 to "-37"		280 V. RMS
AC ripple across 1200 ohm resistors R99, R100, R101 (connect a 1/4 mfd. condenser in series with meter)	Less than	2 V. RMS
AC ripple across 5000 ohm resistor R105 (connect a 1/4 mfd. condenser in series with meter)	Less than	1 V. RMS

PRACTICAL SERVICE SUGGESTIONS

The following suggestions cover possible troubles in the pedal solo unit only. Suggestions for the standard organ system will be found elsewhere in the service manual.

Any trouble in the organ ahead of the matching transformer will not affect the pedal solo unit, but trouble following the transformer will affect both systems equally.

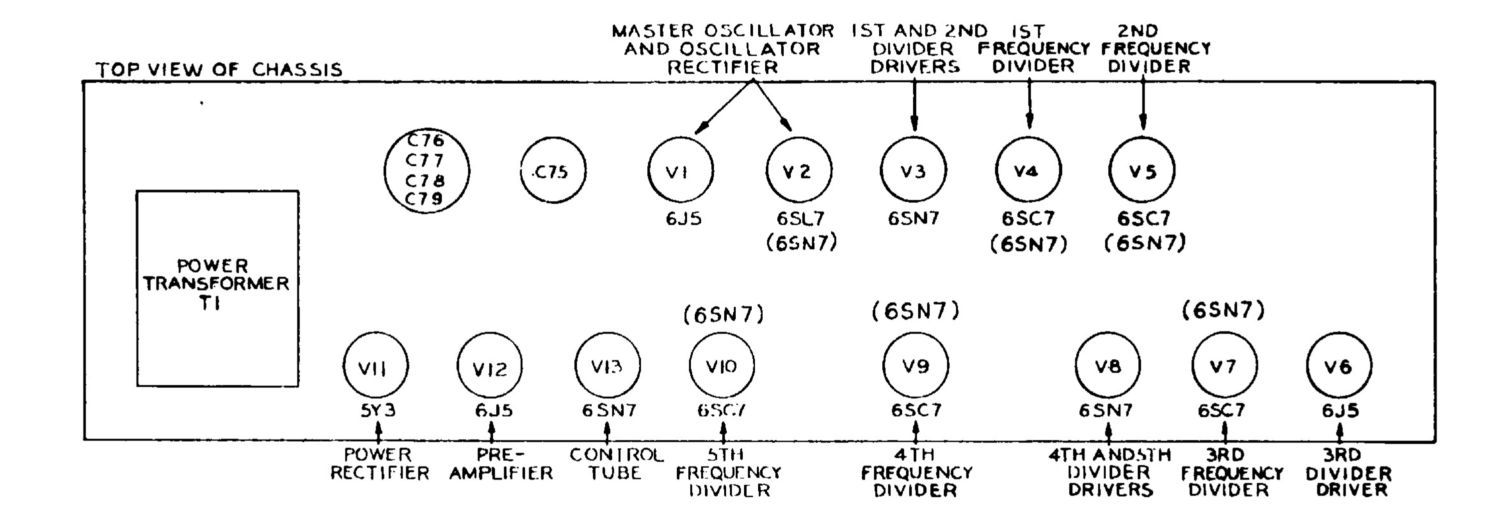
Pedal Solo Unit Does Not Play First make sure that the tubes are lighted, all controls are in playing position, and the rest of the organ plays normally. Several possible causes of trouble are listed below in order of probability.

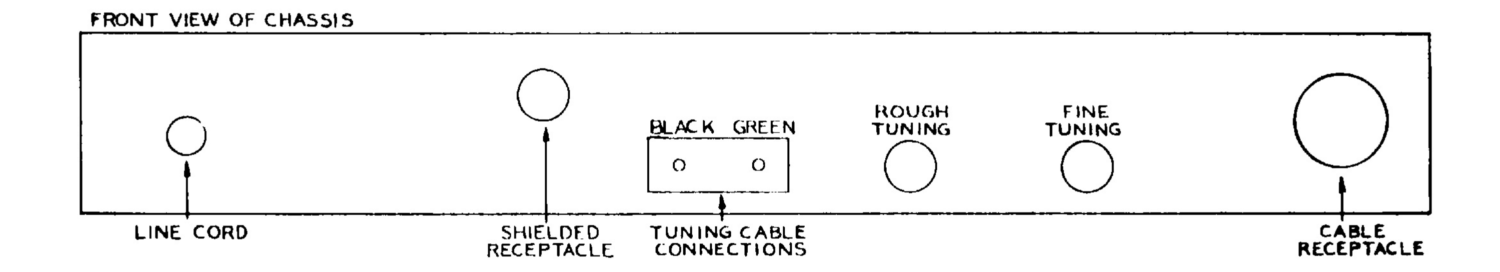
(a) Tubes. The tubes are of standard radio types and can be tested in the usual way. Figure 3 shows their locations in the pedal solo generator

(b) Loose cable connector. See that the 15 pole plug and the shielded plug are inserted tightly into the pedal solo generator.

(c) Keying circuit. A dirty contact in the PEDAL SOLO ON tablet or a defective connection in any part of the keying circuit will prevent removal of the cutoff bias when a key is played. If this is the trouble, grounding pin 15 of the cable plug will make a pedal note sound. The following section, Procedure for Removing Parts, tells how to reach and clean the tablet contacts.

(d) Amplifier or oscillator circuit. The amplifier circuit is conventional in most respects, and voltage measurements will generally serve to identify any trouble. Failure of the master oscillator will make the pedal solo unit fail to play, and voltage readings will be helpful in this case also. Figures 4, 4A, 48 show the locations of all components, and a chart at the end of this section gives their characteristics.





REFERENCE SYMBOLS FOR COMPONENTS REFER TO PEDAL SOLO UNIT SCHEMATIC
TUBE TYPES IN PARENTHESES ARE USED IN TYPE RTC, RTD, RTE.

FIGURE 3 - PEDAL SOLO GENERATOR

Pedal solo note does not sound on one pedal (with any combination of control tablets). The control contact of that pedal is probably dirty and can be cleared by adjusting the pedal busbar shifter as described in the section on manuals and pedals. The same trouble may appear as an irregular sputtering or crackling of a single pedal note.

This effect may also result from an open circuit in the pedal wiring, the pedal to main generator cable, or the main generator wiring, since the control circuit is completed through the main generator.

All pedals fail to play on one stop tablet. If all other tablets play correctly, the signal from the oscillator or one frequency divider is not reaching the amplifier. This may be due to a loose cable plug, a broken wire, or a dirty contact on the tablet. In the latter case, refer to the following section, Procedure for Removing Parts. The schematic diagram, figure 2, indicates which cable wire and frequency divider correspond to each tablet. Figure 5 identifies the tablets and electrical components in the control panel.

All pedals play the wrong pitch (or do not play at all) on one or more low pitched stop tablets. One frequency divider is not operating correctly, in which case all dividers below it will also fall. A cathode-ray oscilloscope connected from ground to the plate of any divider tube should show a rectangular wave, while the plate of any divider driver tube should show a very sharp and narrow negative pulse. If electrolytic capacitor C78 ss open or very low in capacity, all the dividers may fail to operate.

Key thumps or clicks: If capacitor C81 is open, there will be a loud thump each time a pedal is played.

Hum: An excessive 120 cycle hum in the output will result from failure of one of the filter capacitors C75, C71,and C78.

Tuning of individual notes: The individual note tuning system consists of 32 small inductance coils, each of which is adjustable by moving the coll on its iron core. This tuning system is very stable because it has practically no aging effect and is very insensitive to ordinary humidity and temperature changes. However, after long use under adverse climatic conditions it is possible that some pedal solo notes may not be exactly in tune with each other.

Always tune first with the tuning knobs as indicated above. Keep In mind the fact that it is generally desirable to have the pedal solo unit slightly out-of-tune with the organ. If you are sure some notes actually require tuning, proceed as follows:

(a) Disconnect the two cable leads from the G-G terminals on the preamplifier and ground the two wires. Connect one set of oscilloscope plates (either horizontal or vertical) to one G terminal and ground.

(b) Connect the other set of oscilloscope plates to ground and to pin 3 of V6 through a blocking condenser.

(c) Remove the cover of the tuning coil box at the rear of the console, exposing the numbered tuning coils. The wiring diagram shows the location of these coils. Set the fine and rough tuning knobs to their center positions.

(d) Push in the pedal drawbars, turn the vibrato off, and turn all pedal solo tablets off. Using only the first white drawbar on either manual, hold down the second key G key from the top. Hold down the highest pedal.

(e) Loosen the clamping screw on coil 32 and slide the coil carefully forward or backward until the note is in tune as indicated by the oscilloscope wave pattern standing still or moving no more than one cycle in two seconds. Tighten the clamping screw.

(f) Release key and pedal and press adjacent F# key and pedal. Adjust coil 31 in same way. Repeat for all other pedals and coils in chromatic order downward.
It is important to start with the highest pedal and progress downward one pedal at a time because the tuning of the lower notes is dependent upon all of the higher coils. Each pedal adds an increment of inductance in series with all coils above it, and adjusting any single note wlll detune all those below it.

Note: From the prior instructions you can see that tuning the individual notes is a long and tedious process and must be done with extreme care. It should not be undertaken unless you are absolutely certain that the tuning error is great enough to interfere seriously with playing the organ.

PROCEDURE FOR REMOVING PARTS

To remove Control Panel and Clean Contacts

1. Remove four screws holding music rack and place it on top of console.
2. Remove two belt head manual bolts exposed when music rack is removed.
3. Remove two large hex head manual bolts located on underside of generator shelf near rear.
4. Remove two screws passing up through right hand chassis block of lower manual into control panel.
5. Remove one screw holding angle bracket to bottom cover of control panel.
6. Tilt upper manual upward and slide control panel assembly through opening, toward back of console.
7. Remove bottom cover of control panel.
8. Remove four wood screws holding wood frame work to chassis of control panel.
9. Remove knob and loosen nut which holds volume control.
10. Tip wood frame up and slide back until rear wooden strip clears tablet identification strip.
11. Slide pivot rod out of tablet assembly and remove tablets.
12. Remove four #3 screws holding tablet assembly to chassis of control panel and tilt assembly up. Contacts are now visible and can be cleaned by wiping gently with a cloth.

ELECTRICAL PARTS LIST FOR PEDAL SOLO GENERATOR

CONDENSERS

REFERENCE SYMBOL	CAPACITY	VOLTAGE	TYPE
C75	20 mfd.	400	Electrolytic
C76	20 mfd.	300	Electrolytic Used in Generator "Type RTA" only
C77	80 mfd.	150	
C78	30 mfd.	50	
C79	30 mfd.	15	
C76	40 mfd.	400	Electrolytic AO-19131-1 Not Used in Generator "Type RTA"
C77	20 mfd.	350	
C78	20 mfd.	350	
C79	6 mfd.	200	

WIRE WOUND RESISTORS

REFERENCE SYMBOL	OHMS	WATTS	PART NUMBER
R 105 Used in Generator "Type RTA" only	5000	10	
R 106	4500	5	626-060741

VARIABLE RESISTOR

REFERENCE SYMBOL	OHMS
R 118	250

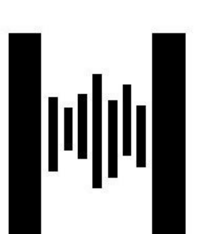
TRANSFORMERS

REFERENCE SYMBOL	FUNCTION	PART NUMBER
T 1	Power 115V. 60 cy.	
T 1	Power 115V. 50/60 cy.	
T 1	Power 230V. 50/60 cy.	003-021320-003
T 2	Audio	
T 3	Output	

THE HAMMOND ORGAN

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ECHO ORGAN EQUIPMENT



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ECHO ORGAN EQUIPMENT FOR THE HAMMOND ORGAN

An echo tone cabinet (or group of cabinets) may be used with any type of Hammond Organ console. The echo cabinet is usually placed at some distance from the console and from the main cabinet; for instance, at the opposite end of a church. An echo switch mounted on the console enables the organist to play through the main cabinet alone, the echo cabinet alone, or both together. Any standard Hammond tone cabinet may be used.

The echo switch has three positions. When it is set to the left the main tone cabinet (or cabinets) will sound, and when set to the right the echo cabinet will sound. With the switch in the center both main and echo will sound simultaneously. The switch controls only the signal circuits, and all cabinets remain energized as long as the console is turned on.

Figures 1 and 2 show how the main and echo tone cabinets are connected to the console. and figure 3 is a schematic circuit of the echo system.

ECHO ORGAN KIT

The echo kit includes all necessary parts for installation in consoles Models B, BC, BCV, BV, C, CV, D, DV, G, RT, B-2, C-2, RT-2, B-3, C-3, & RT-3, with the exception of some early B and BC consoles having no outlet box. For installing kit in a console without an outlet box, or in Model A or Model E console, see special instructions at the end of this section.

A 5-conductor cable must be ordered separately, of suitable length to reach from the console to the echo cabinet, in addition to the desired echo cabinet (or cabinets).

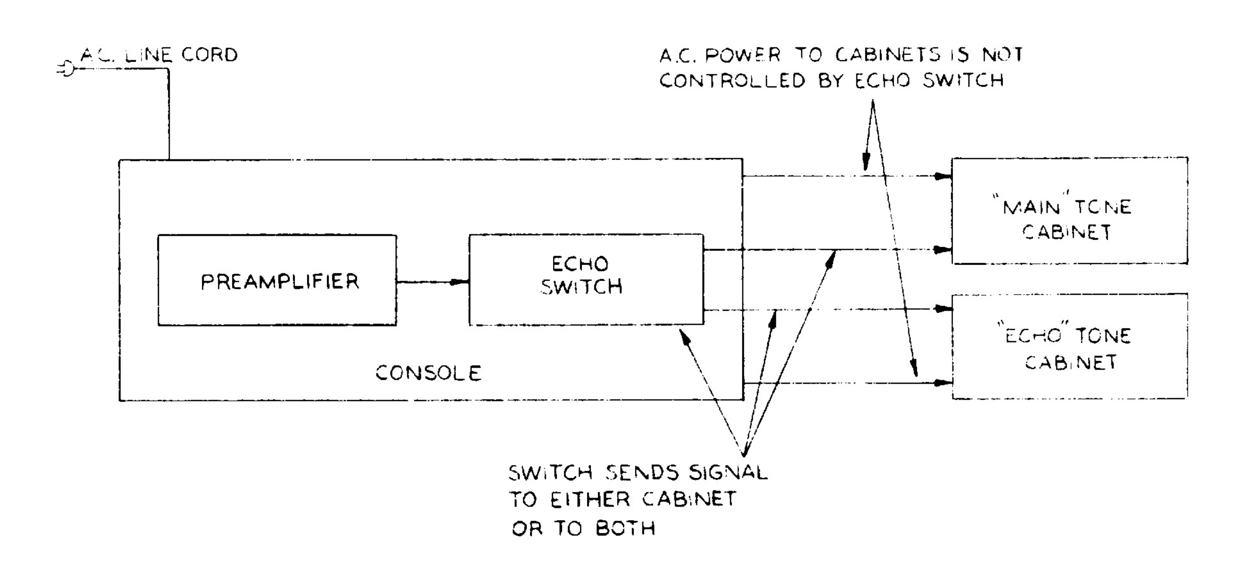


FIGURE 1. BLOCK DIAGRAM OF "ECHO" ORGAN

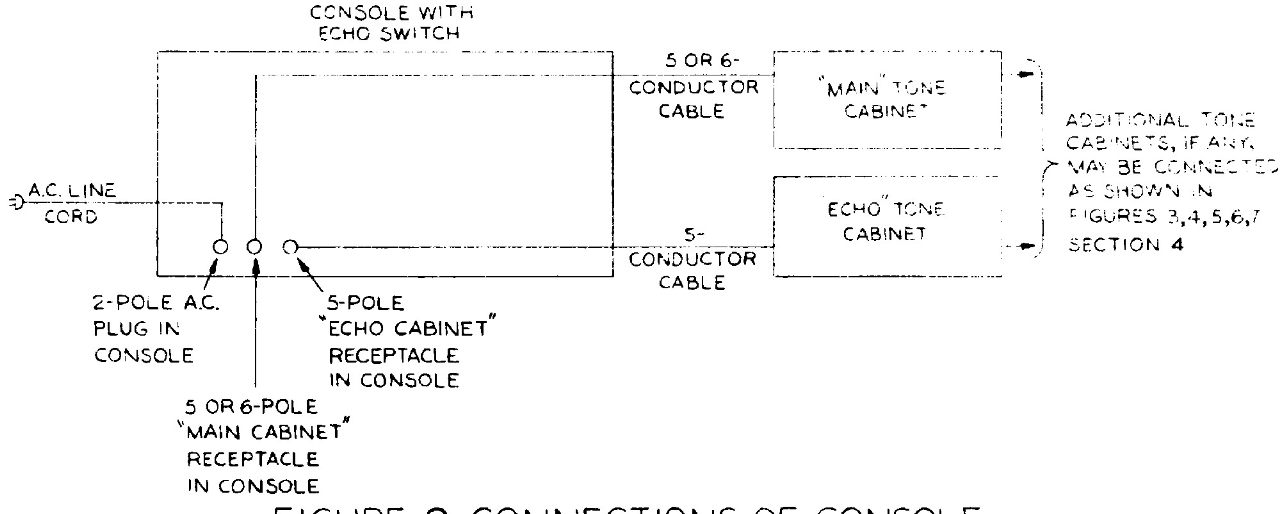


FIGURE 2. CONNECTIONS OF CONSOLE TO MAIN AND ECHO TONE CABINETS

INSTRUCTIONS FOR INSTALLING KIT

1. Disconnect chorus drawbar (if console has chorus generator) from lever inside console by removing coupling pin. Detach vibrato chorus switch (if any) by removing knurled nut from front. Remove four screws in music rack end blocks and remove entire music rack assembly from console.

2. Drill holes for echo switch in music rack base as shown in figure 4. Replace music rack and other parts. Mount echo switch.

Note: Steps 3 and 4 apply only to console models having B in the type designation.

3. Disconnect and remove swell pedal connecting rod. If console has chorus generator, it will be necessary to unfasten preamplifier and rheostat box (leaving wires connected) and remove mounting channel.

4. Remove 4 screws from pedal switch cover panel, remove key at top of wiring tube nearest to swell pedal, raise tube a few inches, and lift pedal switch cover panel.

Note: Step 5 applies only to console models having C, D, G, or R in the type designation.

5. Remove key at top of wiring tube and raise tube a few inches to permit detaching the outlet box.

6. Unfasten outlet box from base of console, open it, knock out proper receptacle hole blank (see figure 5) and mount echo receptacle. Solder connections as indicated in figure 5. Pull twisted pair of wires up through wiring tube. Reassemble outlet box and attach it to console. Replace pedal switch cover if it was raised in step 4.

Note: For consoles not equipped with outlet box, see special instructions at end of this section.

7. Replace any other parts previously removed. Fasten echo wiring panel on top of line panel cover and connect all wires as shown in figure 5.

8. Check for proper operation. If it should happen that the echo cabinet sounds with the switch in main position and the main cabinet sounds with the switch in echo position. interchange the main and echo cable wires at the echo wiring panel.

INSTALLING KIT IN CONCERT MODEL E CONSOLES

In this model the preamplifier is located so far from the line panel that the blue, green, and black wires from the echo panel must be extended to reach the preamplifier. In addition, the black and red cable wires must be extended to reach the echo panel. Otherwise the installation may be made as described above.

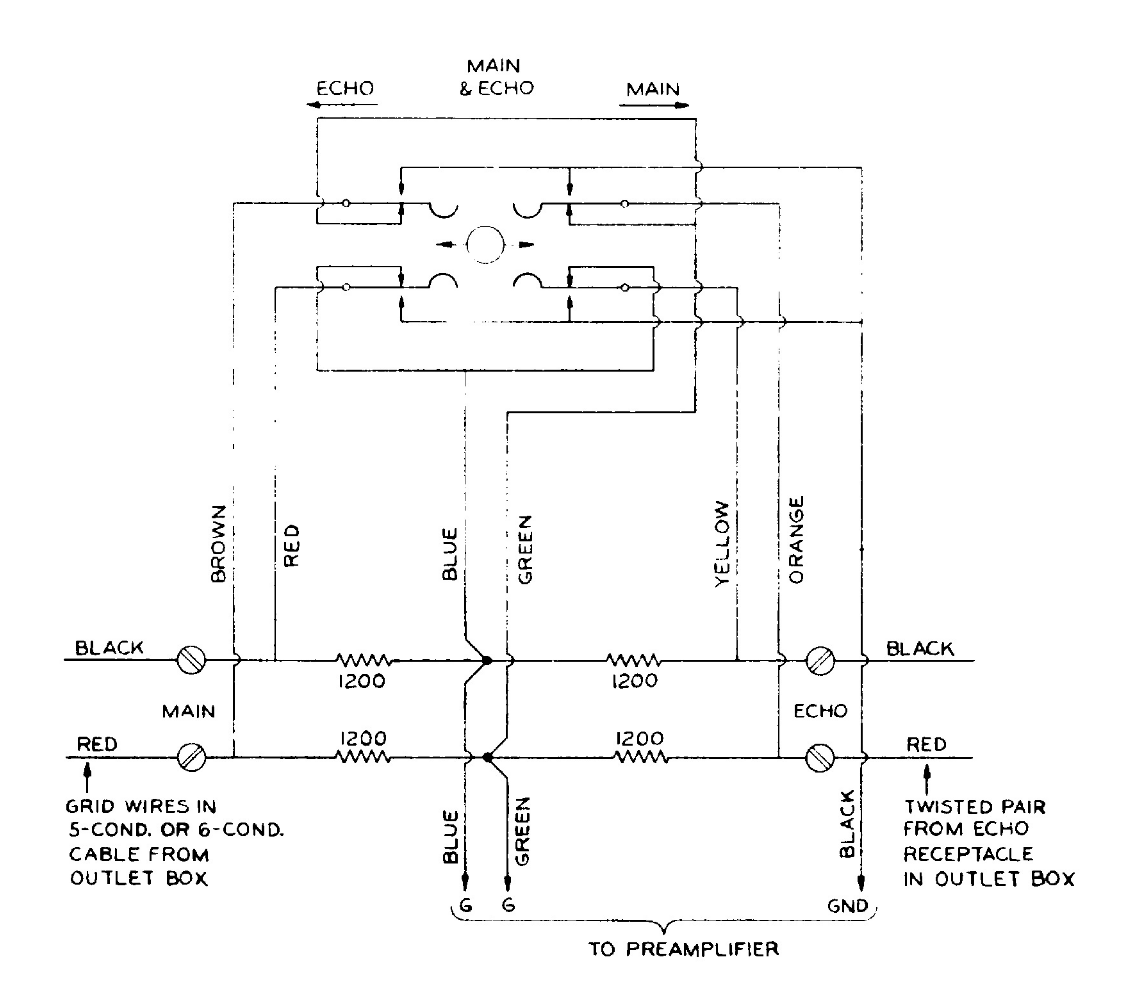


FIGURE 3 - SCHEMATIC DIAGRAM OF ECHO KIT WIRING

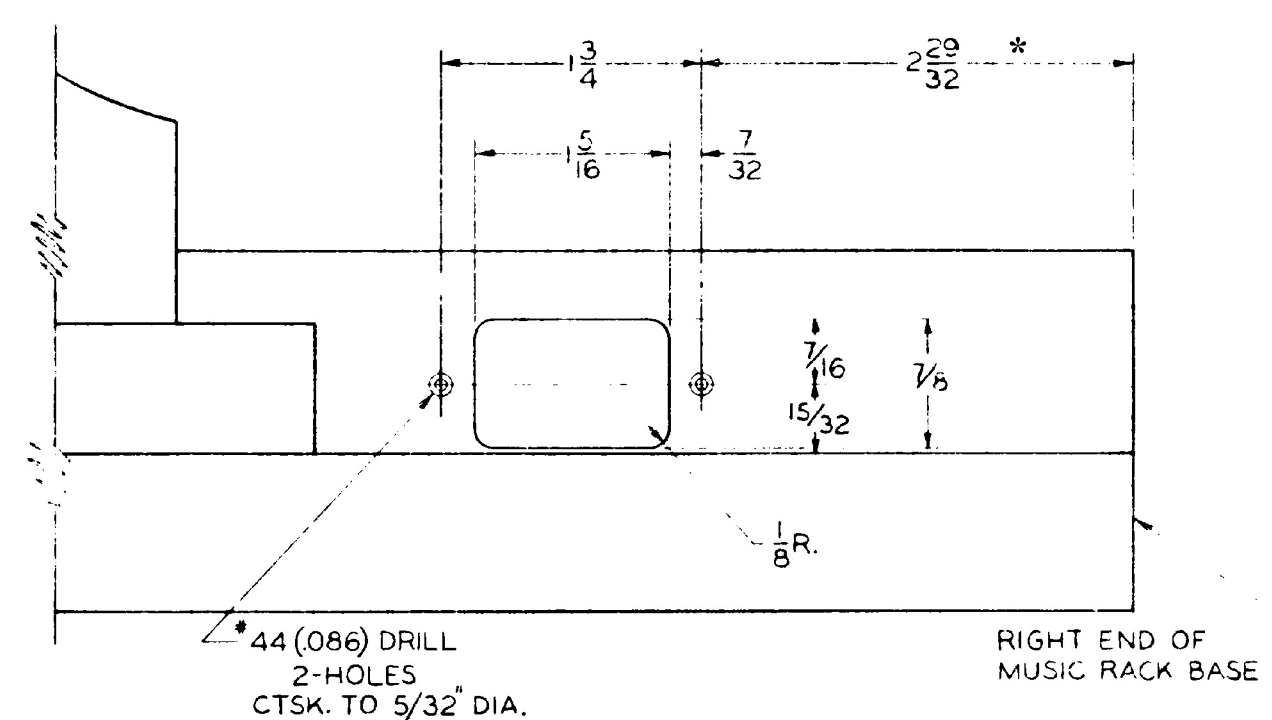


FIGURE 4-HOLES TO BE PROVIDED FOR MOUNTING ECHO SWITCH

*Note: On consoles with Start and Run switches in wood end block (B-3, C-3, RT-3) increase this dimension to 3 & 17/32

INSTALLING KIT IN EARLY MODEL BAND BC CONSOLES WITH NO OUTLET BOX

When installing an echo kit in one of these consoles, it is preferable that an outlet box be installed at the same time.

(a) Obtain one outlet box with 6-conductor receptacle, 2 conductor plug and mounting screws; one 6-conductor plug, and one plug cap, stating the model and serial number of the console.

(b) Follow steps 1, 2, 3, and 4 above.

(c) Mount echo receptacle in outlet box (see figure 5). Cut off 6-conductor cable to proper length to connect it to outlet box, and mount 6-conductor plug and plug cap on remaining piece of cable. Figure 6 shows connections to plug and receptacle.

(d) Follow remaining part of step 6 and follow steps 7 and 8. Figure 7 shows position in which outlet box should be mounted on console.

INSTALLING KIT IN MODEL A CONSOLES

In this model the installation of the echo switch is complicated by the fact that the right hand wooden end block is very thick and has no flat front surface to accommodate the switch plate. Electrically the installation is the same as for the other models.

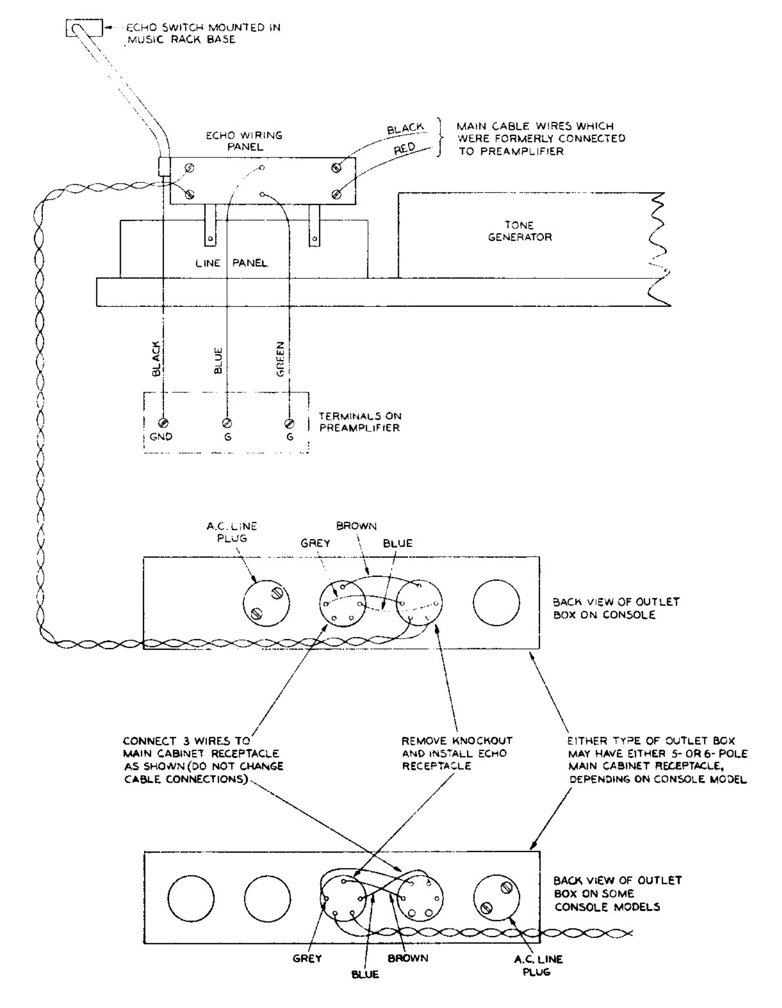


FIGURE 5 - WIRING OF ECHO KIT



FIGURE 6-CONNECTIONS OF CABLE TO 6-POLE PLUG AND RECEPTACLE

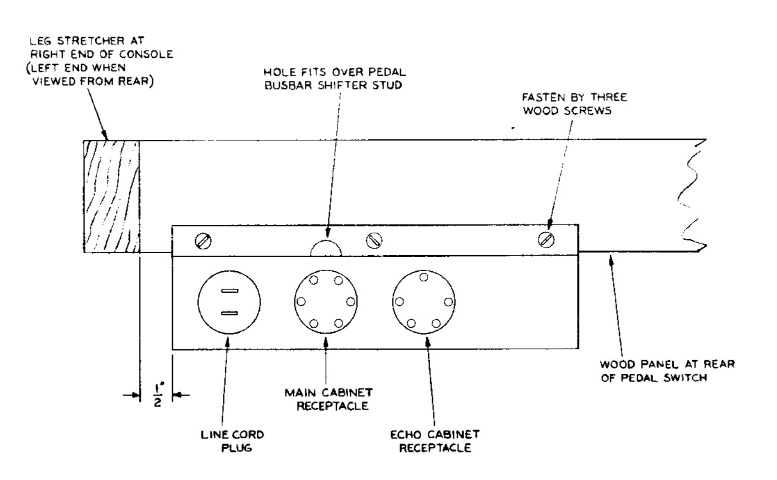


FIGURE 7 - MOUNTING OF OUTLET BOX ON MODEL B OR BC CONSOLE

MONAURAL EARPHONE CONNECTIONS

Earphones can be added to the console for practice purposes so as not to disturb others. Earphones at best cannot replace the tonal quality achieved from the instruments' own speakers but do make the organ more available. One method of attaching earphones is shown in the sketch below, using a reluctance type headset of good quality. Inserting the phone plugs silences the speakers in the console. Wiring is between the preamplifier terminals marked G and the main amplifier input.

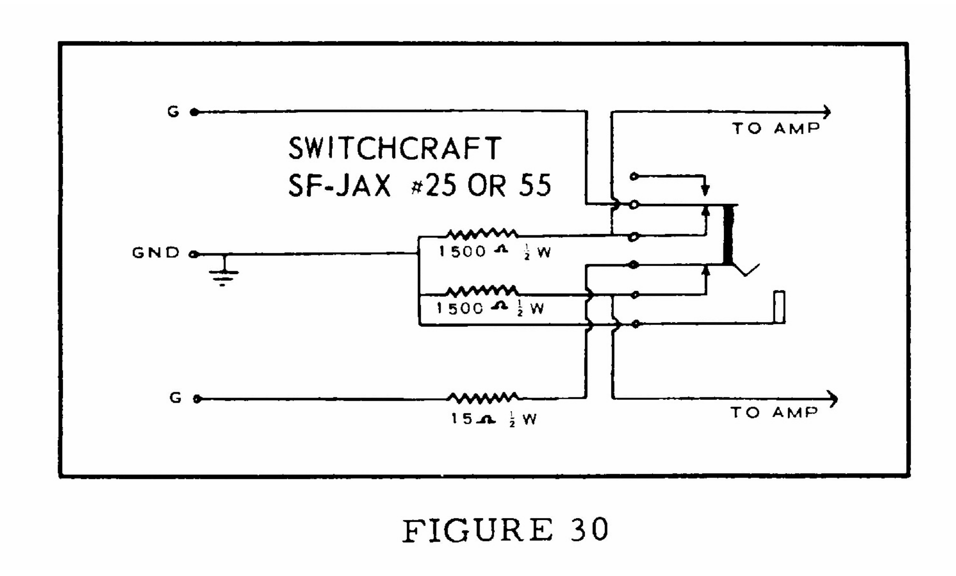


FIGURE 30

STEREO EARPHONE CONNECTIONS

A second method of attaching earphones is given below. This will provide a stereo effect that is well worth the cost and effort expended.

1. Turn over AO-39 chassis and disconnect two black wires from the BN-BK speaker terminal inside of the amplifier. Leave output transformer lead connected. Connect the two wires removed, to the center lug of the three lug terminal strip nearest the front of the chassis and solder connections.

2. Replace amplifier and place a solder lug under the mounting screw nearest the output transformer.

3. Remove the brown wire from the BN-BK speaker terminal on the AO-39 and solder it to the lug just installed.

4. Remove the green wire from the GN speaker terminal on the AO-39 amplifier and splice on an additional length of wire long enough to reach the earphone jack and switch which will be mounted on the front of the console.

5. Solder a wire to the GN speaker terminal on the AO-39 long enough to reach the earphone jack.

6. Solder a wire to the BN-BK speaker terminal on the AO-39 long enough to reach the earphone jack.

7. Identify the green and black wires on the center speaker that connect to the AO-35 or AO-44 amplifier. Remove these wires and connect the green wire to the GN speaker terminal and the black wire to the BN -BK speaker terminal on the AO-39 amplifier.

8. Identify the speaker terminals on the reverberation amplifier AO-35 or AO-44. If a black wire is soldered to the left speaker terminal on the amplifier, reverse the speaker leads at the amplifier so that the gray wire is on the left lug and the black wire is on the right lug of the amplifier speaker terminals.

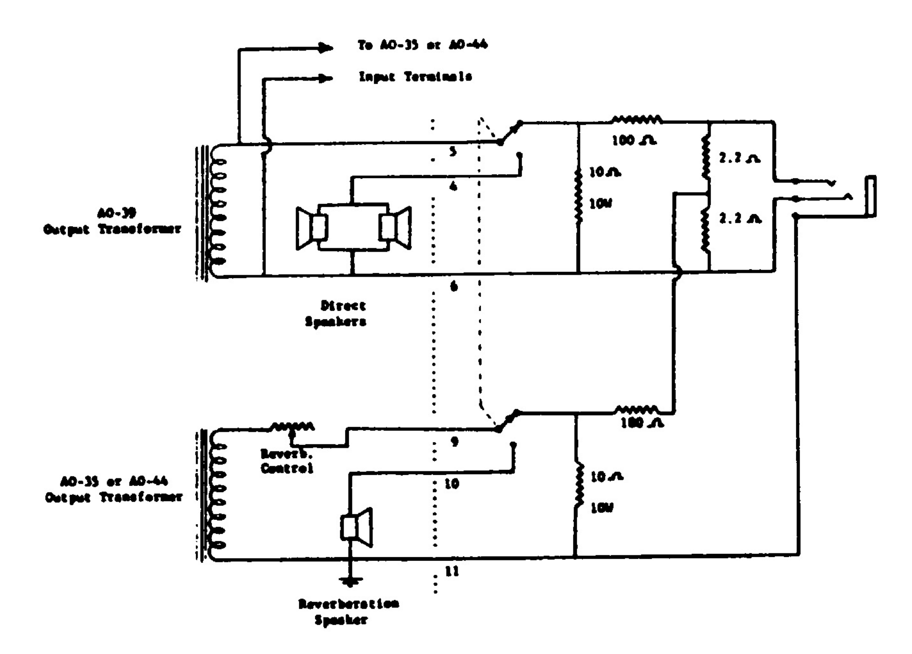
9. Remove the blue wire that is connected to the speaker directly above the reverberation amplifier. Splice on an additional length of wire long enough to reach the earphone jack.

10. Solder a wire to the empty lug on the speaker long enough to reach the earphone jack.

11. Solder a wire to the right speaker terminal long enough to reach the earphone jack. (This terminal is grounded inside the AO-35 or AO-44 chassis.)

12. Mount all components to the right of the dotted line shown on the diagram in a suitable box and connect as shown. Numbers shown under wires identify these leads based on the preceding steps.

13. Mount box containing switch and earphone jack at a convenient point at the front of the console.



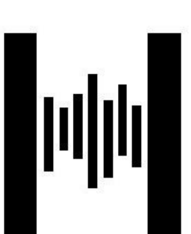
PHONO INPUT

A microphone or record player pickup may be used through the organ if desired. The preamplifier is equipped with a standard phonograph input jack. The input impedance is approximately 1 megohm and the circuit requires a maximum input signal of about ½ volt. A volume control will have to be installed between the microphone or record player input and the organ inasmuch as the swell control of the organ does not affect this input.

THE HAMMOND ORGAN

– 15 –

EXTRA EQUIPMENT
(for organs prior to the **-3** series)



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ATTACHMENT OF EXTRA EQUIPMENT TO THE HAMMOND ORGAN

INPUT EQUIPMENT

The amplification system of the Hammond Organ may be used as an amplifier for a microphone, record player, radio or television receiver, or FM tuner. However, because the amplification section of the instrument is designed for use with the Hammond Organ generating system, and because organ music is rich in low frequencies, the bass quality may be abnormally emphasized when such devices are used.

It is sometimes assumed that a high-grade electric organ will necessarily have a high fidelity sound system. This term, which refers to the ability to reproduce sound accurately, has no meaning when applied to an instrument which originates its own sound. Similarly, flat response, which is desirable in a reproducing system, is not necessarily an advantage in an organ amplifier, where uneven response may be incorporated intentionally to compensate for opposing variations in the generated tones.

It should also be noted that reverberation, which is so desirable for organ music, is less desirable with speech and with some types of music.

For the above reasons it may be found most satisfactory to provide a separate amplification system, but the suggestions in figures 1 to 6 are furnished in case a separate amplifier is not available.

NOTES IN REFERENCE TO FIGURES 1 to 6

The volume control shown in these drawings is required because the expression pedal of the organ does not affect the volume of any attachments. If the record player or microphone has a built-in volume control, no additional control is necessary.

The .0005 mfd. condenser and the 1 megohm resistor are a crystal compensating network and should be omitted if any other kind of microphone or pickup is used.

The voice coil output of a radio or television receiver can be connected in the same way, except that no additional volume control is required. In case the volume is too low, it may be necessary to use a suitable step-up transformer.

The output of some FM tuners can be connected in the same way. A volume control will be required if the tuner does not have its own.

If the organ is to be played at the same time, it should be turned on in the usual manner. If the organ is not to be played, merely push the run switch to the on position.

If the organ has a reverberation unit, it should preferably be turned off when using phonograph or microphone.

Use care in shielding all connections and the volume control, in order to avoid picking up hum. Make connecting leads as short as possible and expose as little of unshielded wire as possible.

If the microphone or phonograph does not have enough signal voltage to give adequate output, a microphone or phonograph preamplifier may be needed in addition.

Preamplifier terminal strip

115 115 P GND G G B+

Remove jumper between "P" and "Gnd". Connect inside wire to "P", connect shield to "Gnd".

Crystal microphone or phonograph pick-up

Shielded wires

NOTE: Volume of this type organ will be reduced somewhat when volume control is turned up. This effect can be eliminated by adding a microphone preamp.

.0005 mfd.

1 megohm

Connect shield to metal case of volume control.

Volume control - 100,000 ohms

FIGURE 1.

Microphone or phonograph connection to tremulant type organs - Models A, B, BA, BC, C and D

Preamplifier

Remove jumper between terminals. Connect inside wire to insulated terminal. Connect shield to grounded terminal.

HI IMP INPUT

Crystal microphone or phonograph pick-up

Shielded wires

.0005 mfd.

1 megohm

Connect shield to metal case of volume control.

Volume control - 100,000 ohms

FIGURE 2

Microphone or phonograph connections to non-selective vibrato organs - Models AV, BV, CV, DV, GV, and RT

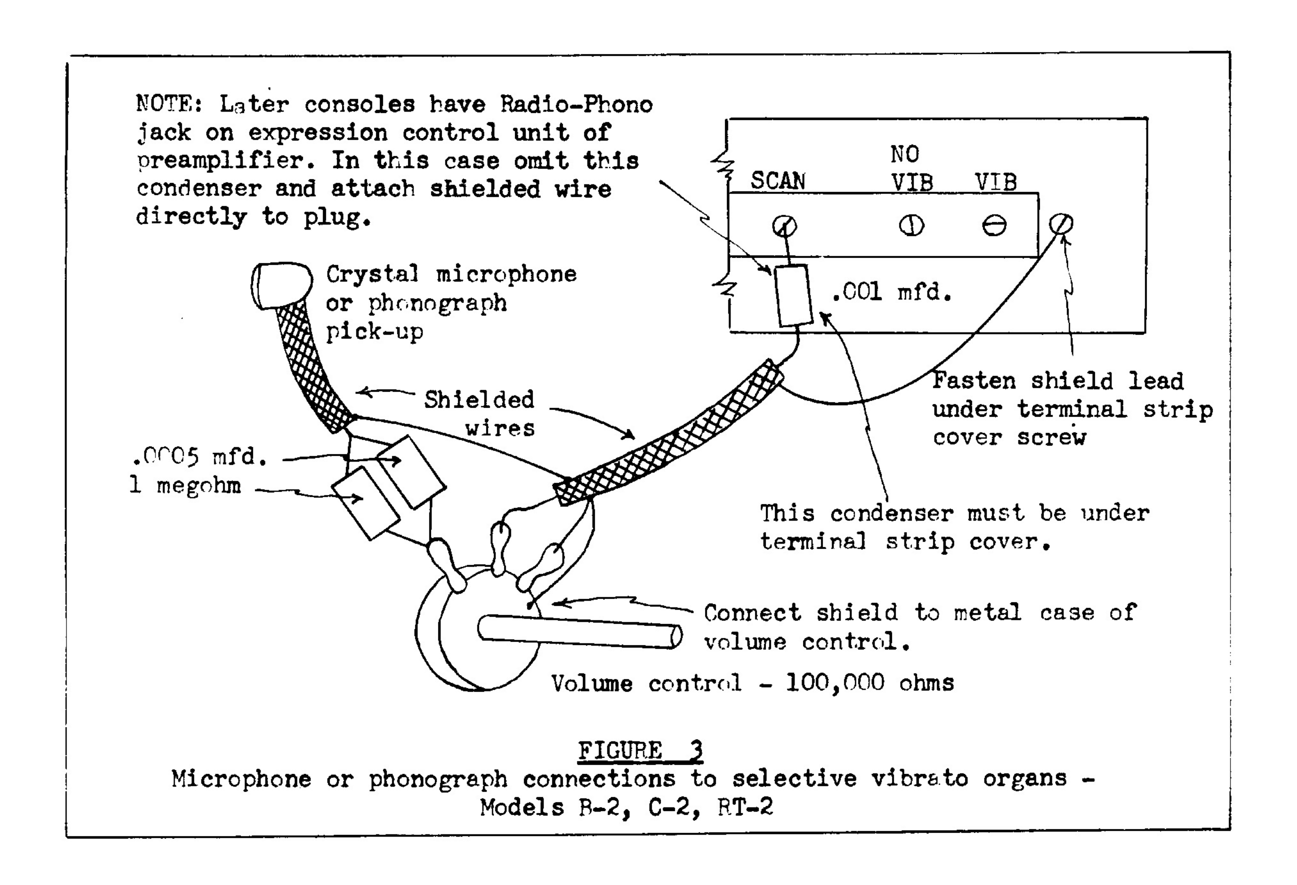


FIGURE 3
Microphone or phonograph connections to selective vibrato organs - Models B-2, C-2, RT-2

OUTPUT EQUIPMENT

The output of any model Hammond Organ can be connected to earphones, disc and tape recorder, or broadcast equipment. If necessary, it may be connected to play through a public address system, although this is generally not desirable. Since so many types of external equipment are in use, the following general suggestions may have to be modified somewhat to fit individual cases.

Figures 7 to 10 show various types of output connections.

PLAYING THROUGH EARPHONES

It is important to use only high quality earphones. We recommend the dynamic or moving coil type, which are quite expensive but give really excellent results. If the organ is not equipped with reverberation control, crystal earphones will be very satisfactory if connected as shown in figure 10. On an organ equipped with reverberation control, the power amplifier connection is best, and good quality magnetic earphones will give quite satisfactory results. Crystal earphones can be used in this circuit, but are likely to be less satisfactory than the best quality magnetic units.

For Home. Church or Concert Model Organ (Models A. AV, B, BA, BC, BV, BCV, B-2. B-3, C, CV, C-2, D, DV, E, G, GV, RT, RT-2), the preferred connection is to the power amplifier in the tone cabinet, if the organ is equipped with reverberation control, since this provides reverberated signal to the earphones. Refer to figure 7, if tone cabinet is type HR-40 or JR-20, or to figure 8 for other models. If crystal earphones are used, connect a .1 megohm resistor in series to avoid excessive high frequencies.

If the organ does not have reverberation control it is equally satisfactory, and often more convenient, to connect to the console preamplifier as shown in figure 9. If crystal earphones are used with this circuit, connect a .1 megohm resistor in series to avoid excessive high frequencies.

Crystal earphones will give better results if connected as shown in figure 10.

RECORDING

Because there are many types and brands of tape, wire. and disc recorders, it has not been possible for us to test each make and give definite recommendations for obtaining good recordings. For specific questions regarding connections to your recorder, we suggest that you contact the manufacturer. Many low-priced recorders do not reproduce low frequencies well. and this may cause a lack of bass response in the reproduced organ music. Often the deficiency is chiefly in the playback system of the recorder, and in this case results will be much better if the organ speaker or tone cabinet is used for playback.

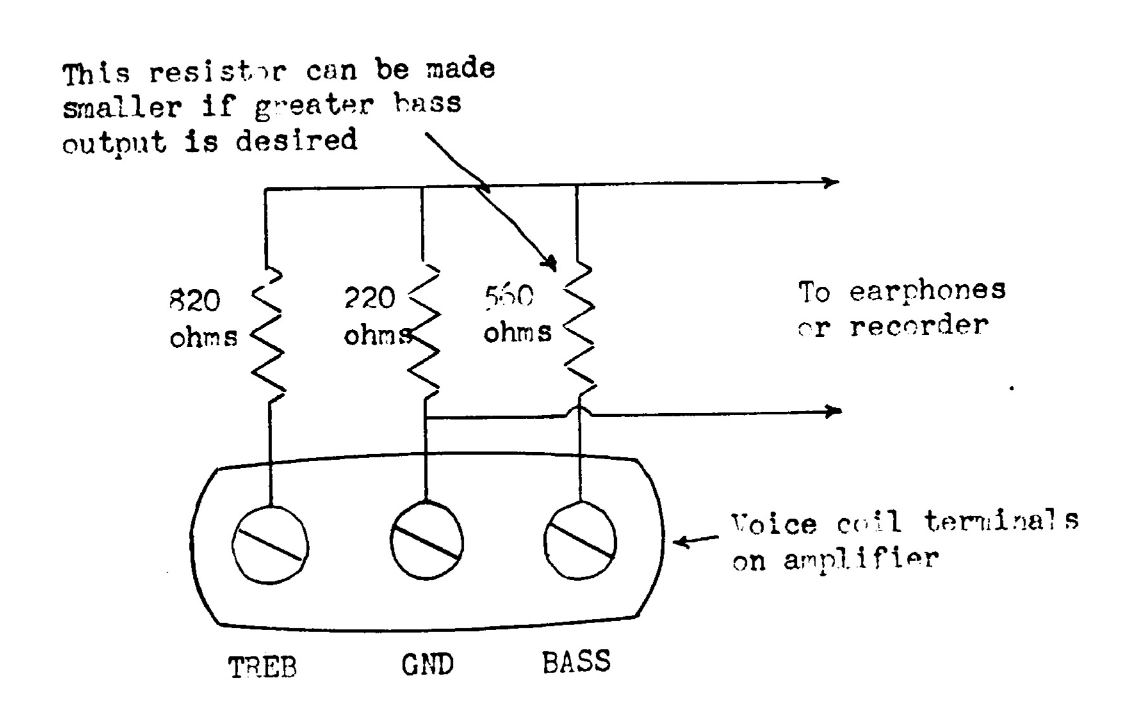


FIGURE 7
Output connections to double channel power amplifier

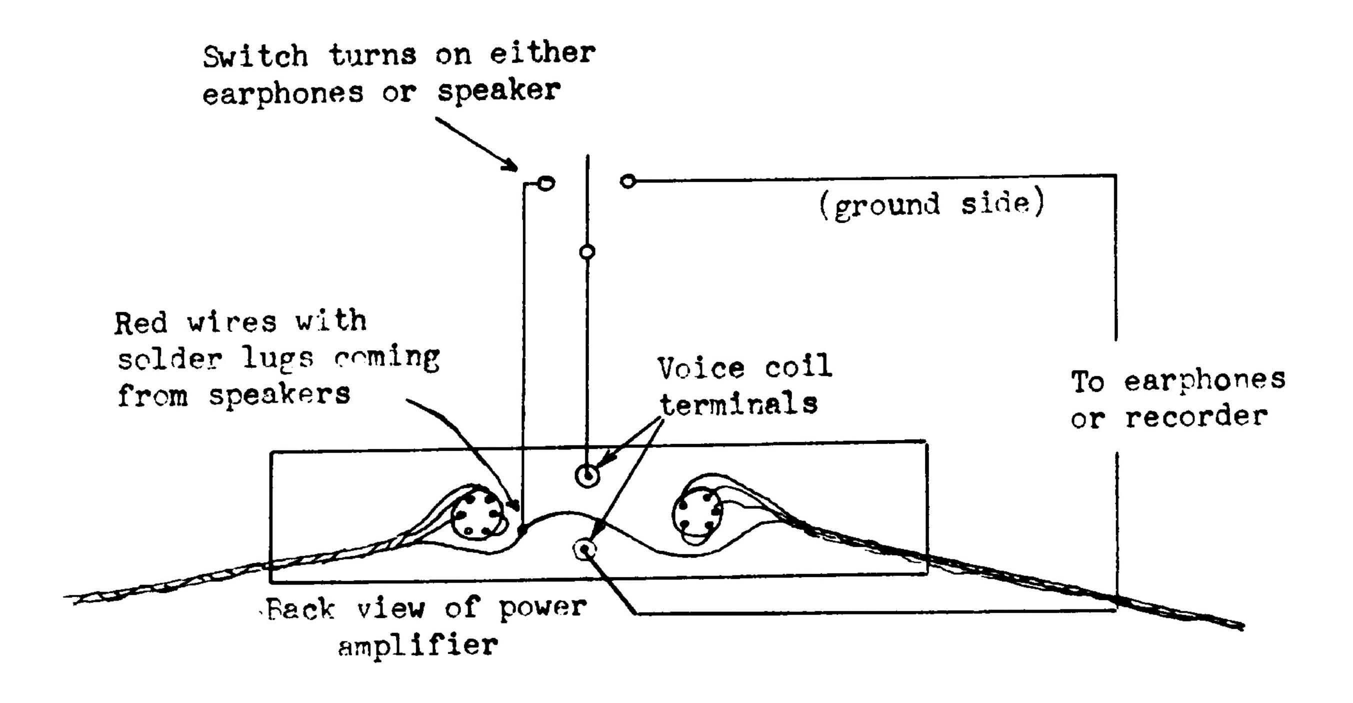


FIGURE 8
Output connections to single channel power amplifier

While the microphone supplied with the recorder may be used, best results are generally obtained by feeding the signal electrically from the organ to the recorder.

For Connecting Electrically To The Power Amplifier (Home. Church. and Concert Models A, AV, B, BC, BCV, BV, B-2, C, CV, C-2, D, DV, E, G, GV, RT, RT-2). see figure 7, if tone cabinet is type HR-40 or JR-20, or figure 8 for any other type of tone cabinet. This is the best arrangement if the organ is equipped with reverberation control, for it provides desirable reverberation in the recorded music. To play back through the organ speaker, connect the recorder output to the organ as directed under microphones and record players on a previous page.

For Connecting Electrically To The Preamplifier (Home, Church and Concert Models) refer to figure 9. This is a convenient pace to make connections if reverberation is not available or is not desired. With this arrangement, the recording can be played back through the organ tone cabinet by merely transferring one wire from the input terminal of the recorder to its output terminal.

For Recording With A Microphone (any organ model), place the microphone at least several feet from the organ speaker. The quality of the recordings will depend somewhat on the acoustics of the room, and it will be necessary to experiment with placement of the microphone to get best results.

BROADCASTING

The recommendations above for recording apply also to broadcasting. Feeding the signal electrically is preferable where possible, and the power amplifier connection shown in figures 7 and 8 is desirable because it gives the benefit of reverberation. The voice coil circuits are of 1 to 8 ohms impedance (depending on type of tone cabinet), with one side grounded and the output voltage is of the order of 1 to 2 volts at normal playing levels. A coupling transformer may be used if it is necessary to isolate the circuits.

The G to G Connection shown in figure 9 is a 200 ohm circuit with grounded center tap, and the signal voltage at normal playing levels is of the order of 2 volts.

If microphone pickup is preferred, the usual arrangement is to place a microphone about three feet above the top of the tone cabinet and inclined at an angle of about 45 degrees. Because types JR-20, H-40, and HR-40 tone cabinets use bass and treble speakers pointed in different directions, the microphone should be placed at least 10 to 15 feet from cabinets of these types.

CONNECTING TO PUBLIC ADDRESS SYSTEM

It is not recommended that Hammond Organs be connected to play through a public address system. Most PA systems emphasize the higher frequencies, particularly in the voice range, and this will result in a serious lack of bass response in the organ music. In addition, the usual placement of PA equipment, with many speakers distributed over an area, tends to diffuse the organ music beyond a useful degree. If it is essential that such a connection be made, use power amplifier output connections shown in figures 7 and 8.

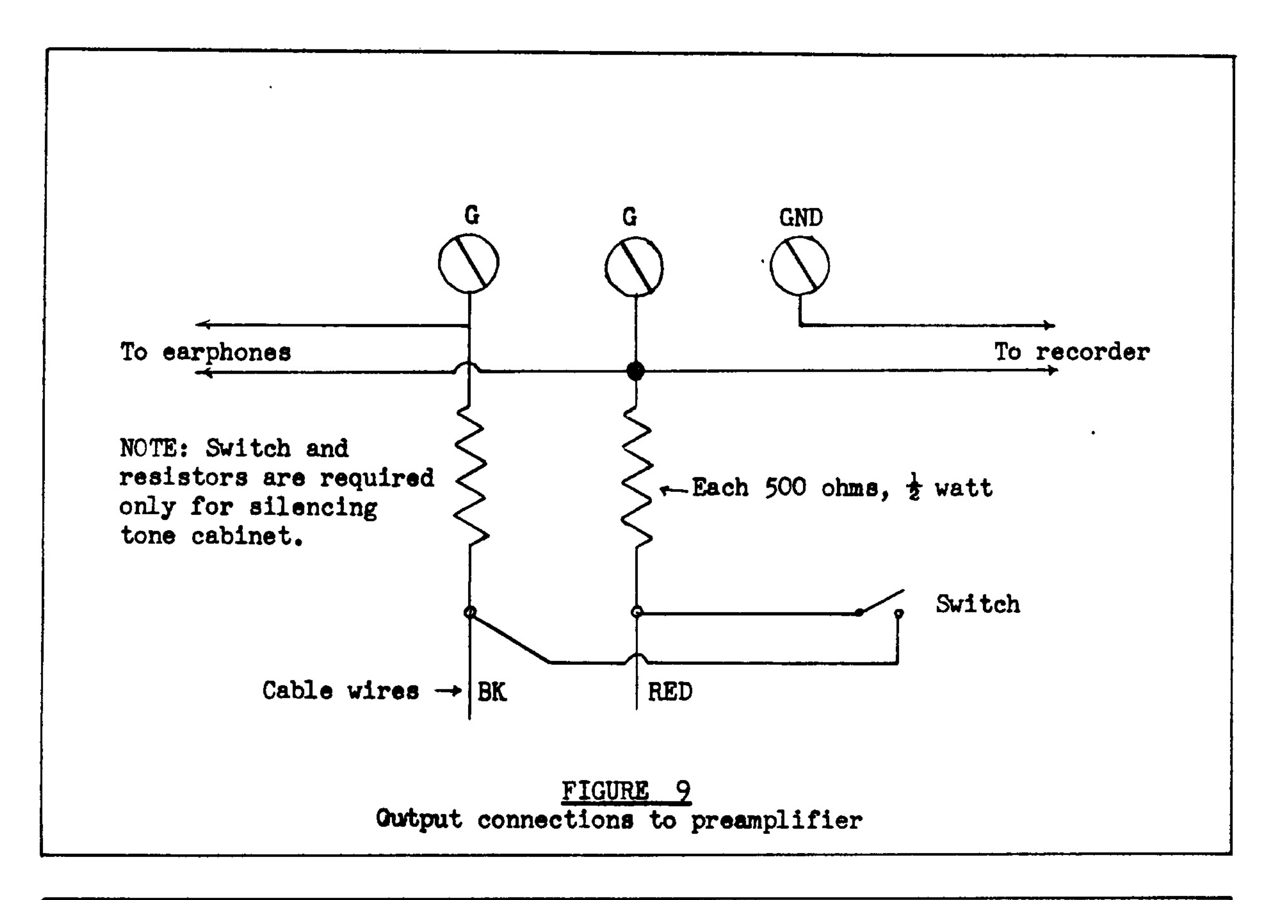


FIGURE 9
Output connections to preamplifier

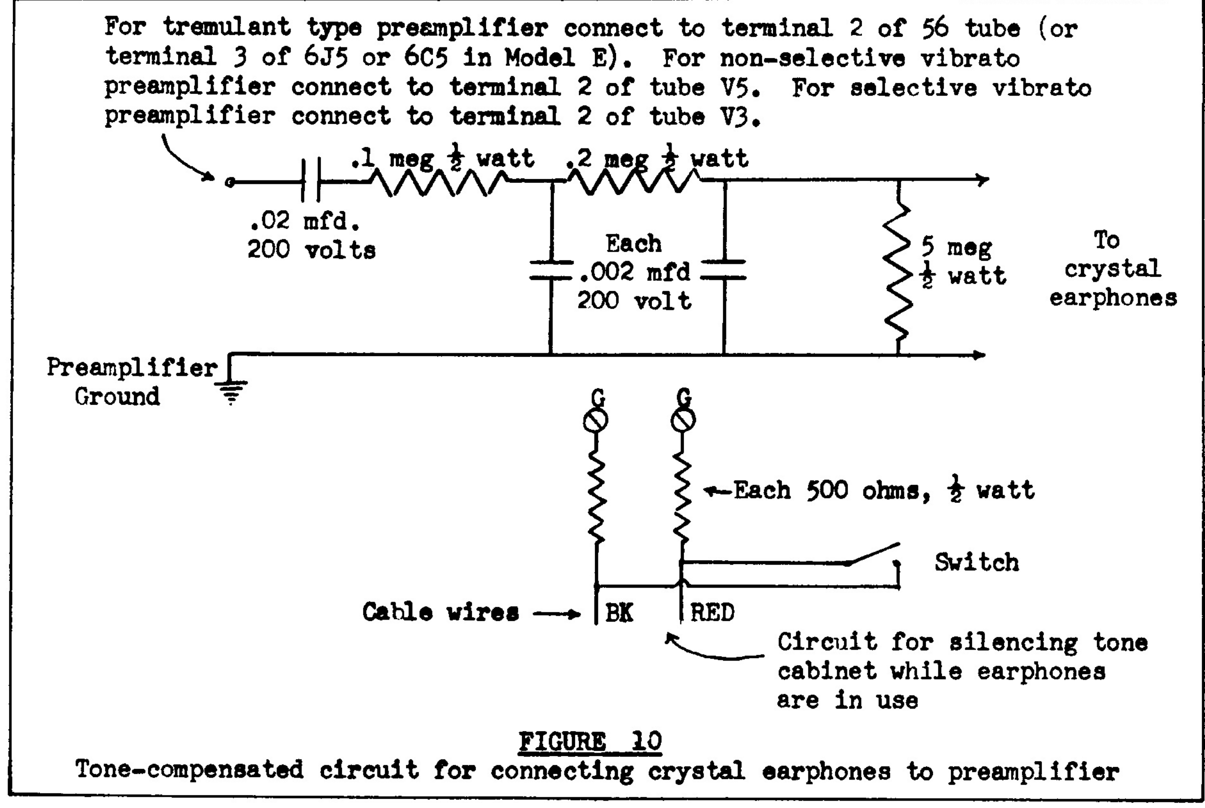


FIGURE 10
Tone-compensated circuit for connecting crystal earphones to preamplifier

CONSOLE HEATER

In very humid climates and in other locations where the Hammond Organ is exposed to extreme dampness, it is often advisable to install a heater in the console to keep the interior of the instrument dry and to reduce the possibility of excess moisture causing damage to electrical parts.

A heater designed for this purpose (was) available 1n kit form from the factory. This kit includes all necessary mounting parts and may be installed by the service technician in any Hammond organ console in a few minutes time.

INSTALLATION OF HEATER IN MODEL A CONSOLES

1. Attach the special bracket furnished with the kit to heater socket as shown in figure 2,using two screws and lock washers. All mounting holes in the special bracket are tapped for screws, so no nuts are necessary.
2. Remove back of console and attach heater to flange at upper left hand corner of rheostat box as shown in figure 2, using the remaining two screws, flat washers and lock washers furnished with kit.
3. Remove power terminal panel cover and solder heater cord ends to terminals 8 and 13 counting from left of panel as shown in figure 1.
4. Replace terminal panel cover, plug heater in socket and attach red instruction tag to power cord plug.

INSTALLATION OF HEATER IN MODEL B, C, & D CONSOLES

1. Remove back of console and place heater socket 3/4″ to the left of oil cup mounting plate as shown in figure 3 and mark location of two mounting holes. These holes should be in line with oil cup mounting screws. (Consoles are now being furnished with these holes punched in mounting plate.)
2. Drill holes for heater socket mounting, using a #24 or a 5/32″' drill.
3. Drill another similar hole for cable clip 8 3/4″to the left of holes just drilled and in line with same.
4. Using two of the screws, lock washers and nuts provided with the kit, mount the heater socket and one cable c11p. The clip is held in place by the left hand socket mounting screw.
5. Mount the other cable clip with the remaining screw and fasten heater cord in place.
6. Remove power terminal panel cover and solder heater cord ends to terminals #8 and #13 counting from left of panel as shown in figure 1.
7. Replace terminal panel cover, plug heater in socket and attach red instruction tag to power cord plug.

INSTALLATION OF HEATER IN MODEL E CONSOLE

1. Remove back of console and place heater in position at left end of oil tubs mounting plate as shown in figure 4 and mark location of two mounting holes. Holes should be 3/16″ from top edge of plate and left hole should be 1/4″ from end.

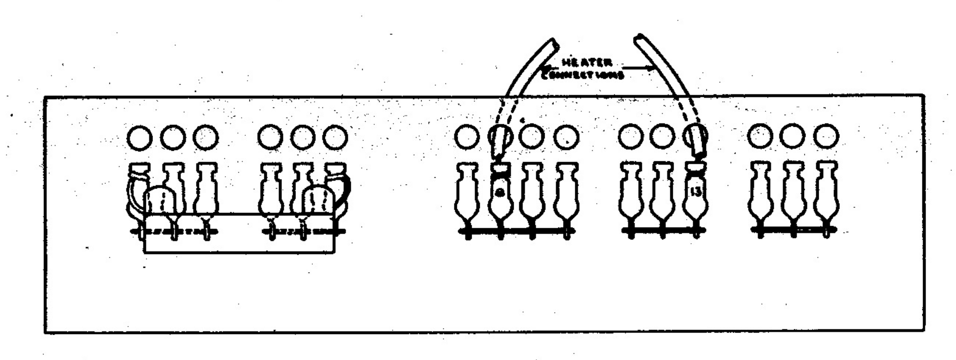
2. Drill holes for mounting heater socket, using a #24 or a 5/32″ drill.

3. Using two screws, lock washers and nuts provided with kit, mount heater socket and one of the cable clips. The clip is fastened by the left hand socket mounting screw.

4. Mount the remalnlng cable clip on post supporting run motor oil tube and fasten heater cord in clips.

5. Remove power termlnal panel cover and solder heater cord ends to termlnals #8 and #13 counting from left of panel as shown in Figure 1.

6. Replace terminal panel cover, plug heater in socket and attach red instruct10n tag to power cord plug.



POWER TERMINAL PANEL
FIGURE 1.

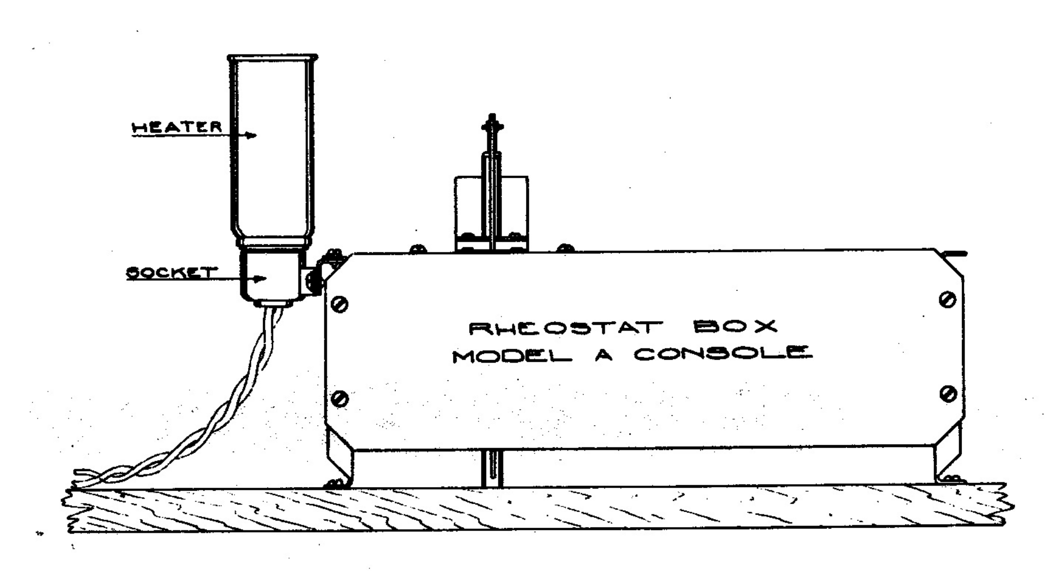
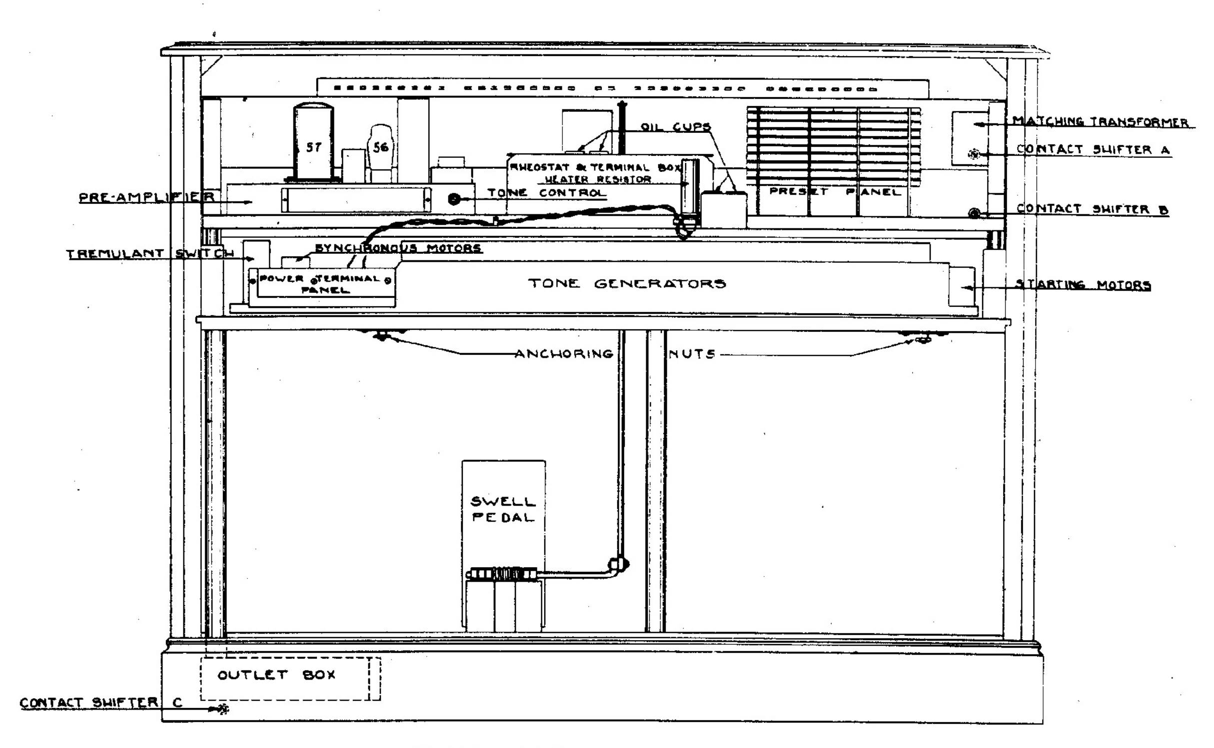
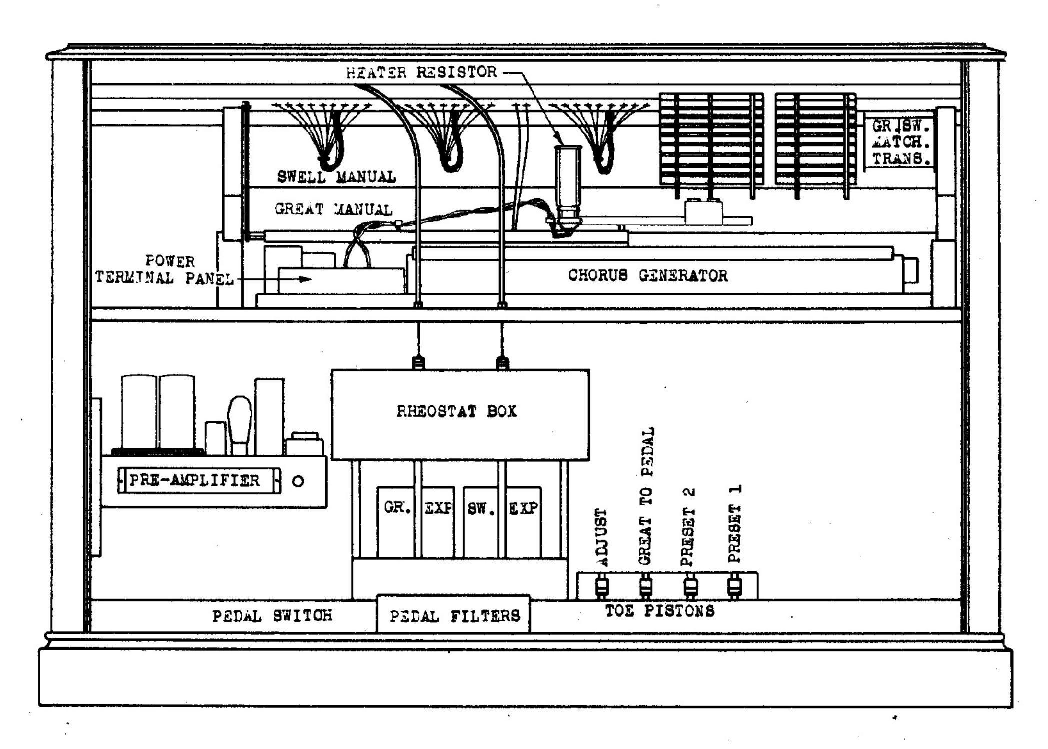


FIGURE 2.



REAR VIEW OF CONSOLE
WITH BACK REMOVED

FIGURE 3



LOCATION OF
HEATER RESISTOR
MODEL E CONSOLE
FIGURE 4.

THE TUNING FORK REGULATOR

The Hammond Organ is furnished in several models designed to operate from a closely regulated 25, 50 or 60 cycle current source. The tone generators are driven by synchronous motors and any variations in frequency will vary the speed of the motors and thus the pitch of the instrument. For example, a frequency variation in 60 cycle current of ½ cycle is noticeable in the output of the organ, and a variation of as much as 12 cycles is definitely objectionable.

The tuning fork regulator is a device of our manufacture which is designed to furnish sufficient closely regulated current of proper frequency to operate the organ from unregulated AC or converter AC as produced by a DC to AC rotary converter.

Start motors, preamplifier and power amplifiers are not critical to slight frequency variations, so when the frequency regulator is used it is connected to furnish regulated current only to the synchronous run motors.

MODEL G REGULATOR

The Model G regulator is designed for AC operation only, and may be energized by any 23 to 63 cycle line. Current consumption is approximately 125 watts. This must be taken into consideration when the organ is to be operated from the output of a DC to AC converter. Failure to provide a converter of adequate size may result in low line voltage and impaired operation of the instrument.

CIRCUIT

Figure 1 shows a circuit diagram of the regulator. A straight vibrating arm is used, with push-pull pick up coils and a permanent magnet. The signal is passed through a push-pull resistance coupled circuit consisting of two 6F5-G tubes and then into two RK-49 output tubes.

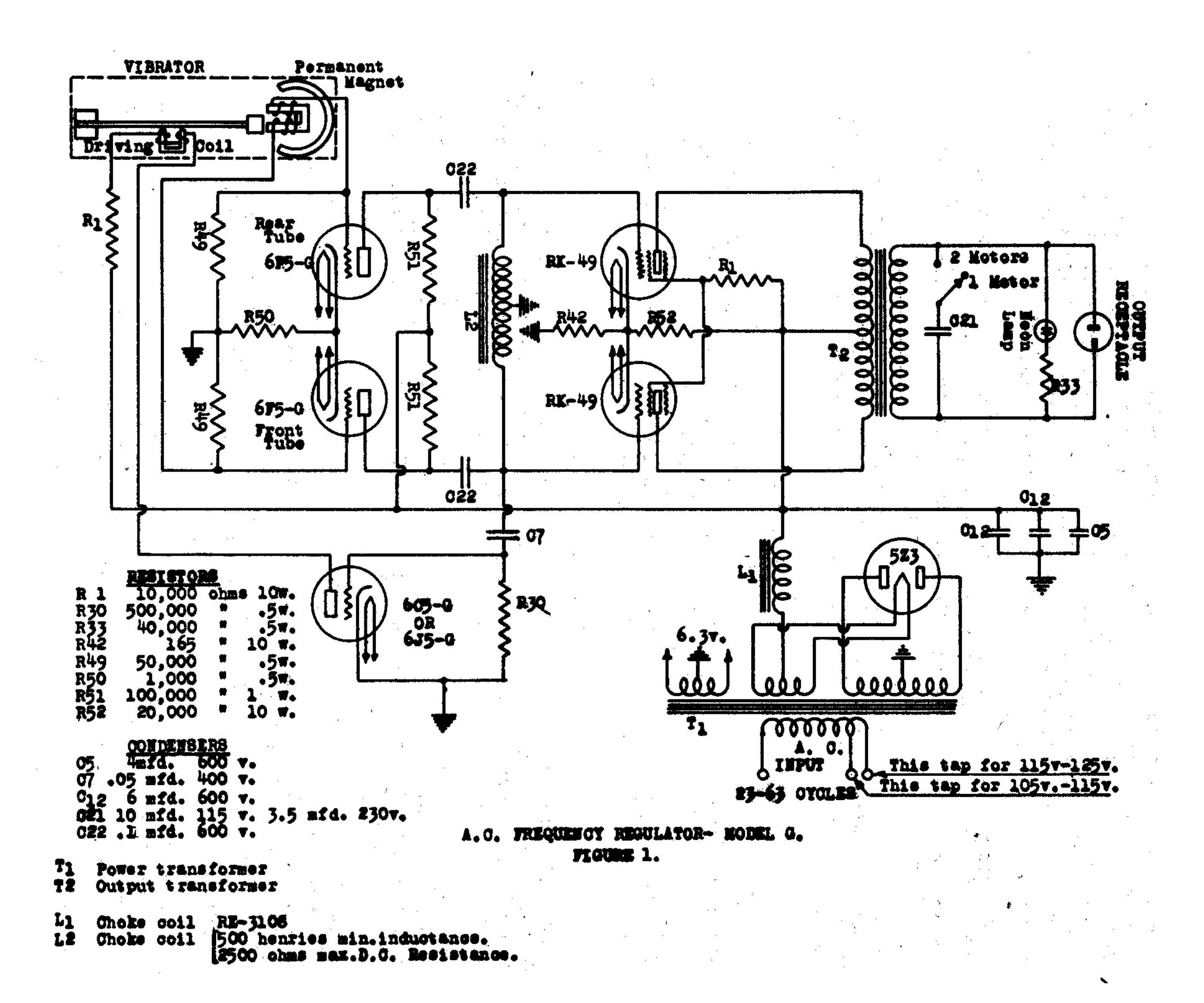
R-42 and R-52 furnish grid bias to the tubes, while R1 provides proper screen voltage for the output tubes. Oscillation is maintained by a driving coil fed through a 6C5-G or a 6J5-G tube. (These tubes are interchangeable).

A small neon glow lamp across the output indicates proper operation of the regulator. Resistor R-33 protects the neon lamp in regulators having 230 volt output. The output switch connects a power factor correcting condenser in order to obtain maximum output when two running motors are to be supplied. The power supply circuit employs a full wave rectifier with a single choke filter and an oil condenser block.

The 115 and 230 volt models differ in the power transformer and output transformer used. Power transformers for both voltages have marked taps to compensate for slight line voltage variation. Models for 50 and 60 cycle output differ only in the vibrating reed.

Tubes used: 1 5Z3, 2 RK-49, 2 6F5-G, and 1 6C5-G or 6J5-G.

NOTE: Model G Regulators of 115 volt - 60 cycle output serial numbered below 1101, 115 volt - 50 cycle below 1060, and 230 volt - 50 cycles below 2059 used two 6L6-G tubes instead of RK-49s. Also choke L1 and resistor R1 were not used, and R52 was 20,000 ohms.



A.C. FREQUENCY REGULATOR- MODEL G.
FIGURE 1.

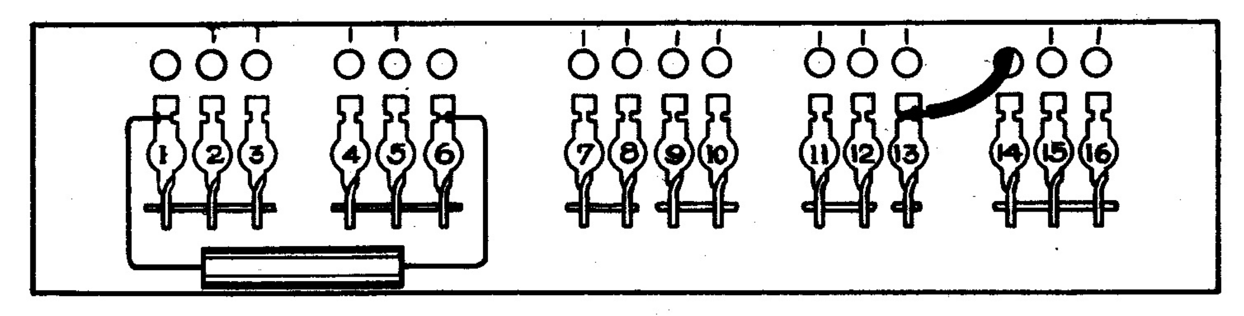
ADJUSTMENT OF PITCH

Adjustment of pitch is possible by moving a weight on the vibrating arm. A single weight is provided for this purpose. Moving this weight toward the center of the arm raises the pitch, and moving it toward the end w111 lower the pitch. The range of the pitch adjustment is approximately 430 to 460 for middle A (normally 440). This pitch may be checked by means of a 60 cycle synchronous clock, which is connected to the regulator receptacle and compared with any other accurate timepiece.

If the electric clock checks exactly, the organ pitch will be A 440. A difference of two seconds in an interval of 14 minutes and 40 seconds w1ll change the pitch one part in 440. For example, if the synchronous clock indicates 14 minutes and 48 seconds in an actual interval of 14 minutes and 40 seconds, the organ pitch will be 444 for middle A.

INSTALLATION

In order to use the Model G regulator with an organ, a change in the wiring on the power panel inside the. console is necessary. This change in power wiring is shown in figure 2.



VIEW OF LINE PANEL AFTER CHANGES ARE MADE
FIGURE 2.

These changes are made as follows:
1. Move blue wire from 14 to 13. (Do not make any other changes in 13)
2. Cut out jumper between 8 and 9.
3. Cut out jumper between 12 and 13.
If serial number of Console is below No. 328 it will be necessary to interchange wires 8 and 9 in order to make revamped panel connections check with diagram shown above. If serial number is below No. 775 it may also be necessary to interchange wires 12 and 13.

In addition to above changes, one of the power circuits shown in figures 3 and 4 should be used. Also, the console-to-cabinet cable must be spliced to separate the power cord as shown in figure 5.

Figure 3 shows a typical installation or the Model G regulator for use on an unregulated frequency A.C. line.

Figure 4 shows a typical installation where the unregulated A.C. is supplied by a rotary converter.

In both or these figures, the switch #2 is provided to eliminate undesirable noise which is introduced through the amplification system if the console is started after the amplifiers have been turned on. Switches #1 and #2 should both be located near the console.

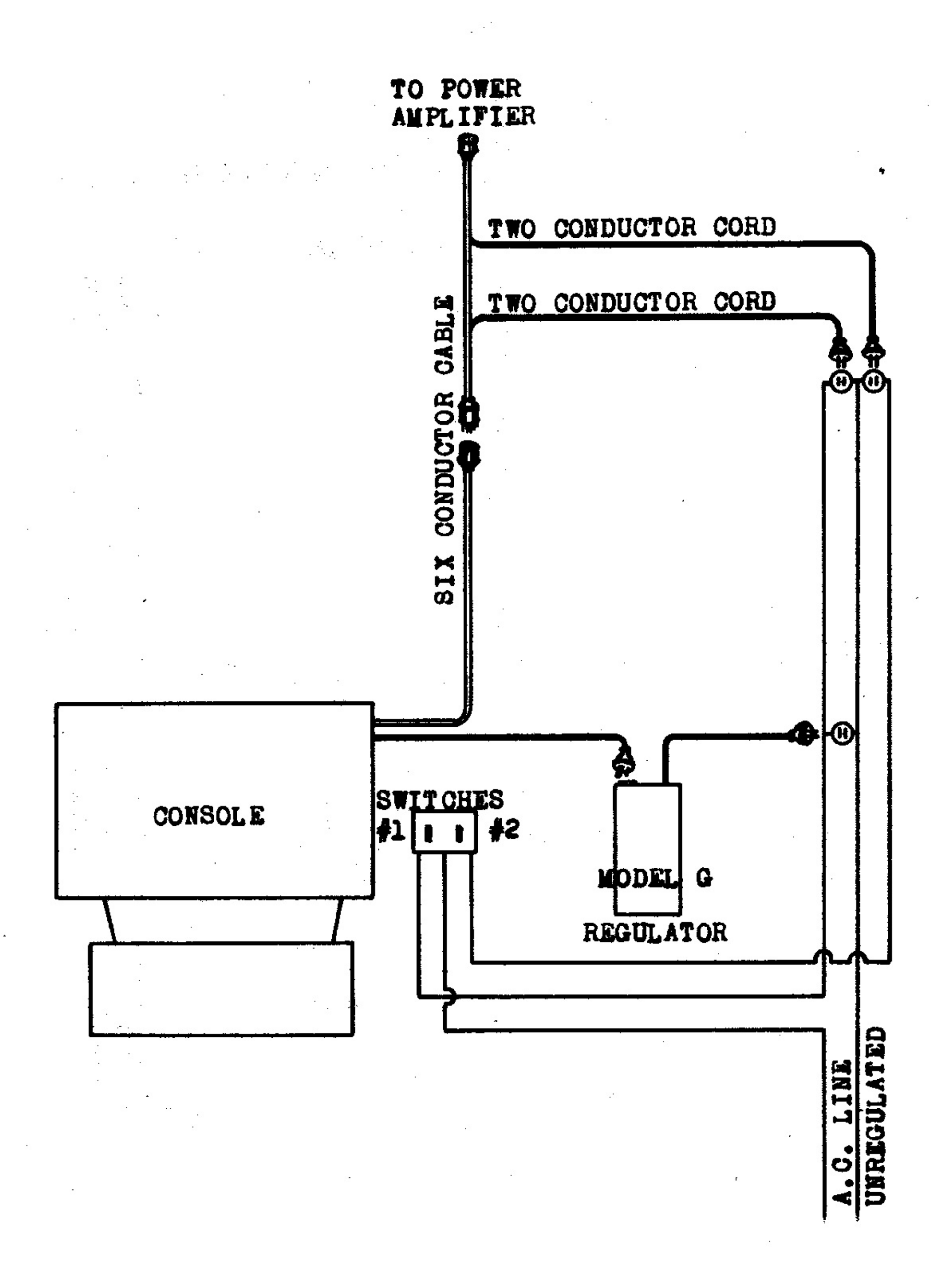

TO POWER
AMPLIFIER
TWO CONDUCTOR CORD
TWO CONDUCTOR CORD
SIX CONDUCTOR CABLE
CONSOLE
SWITCHES
#1
#2
MODEL G
REGULATOR
A.C. LINE
UNREGULATED

Figure 3

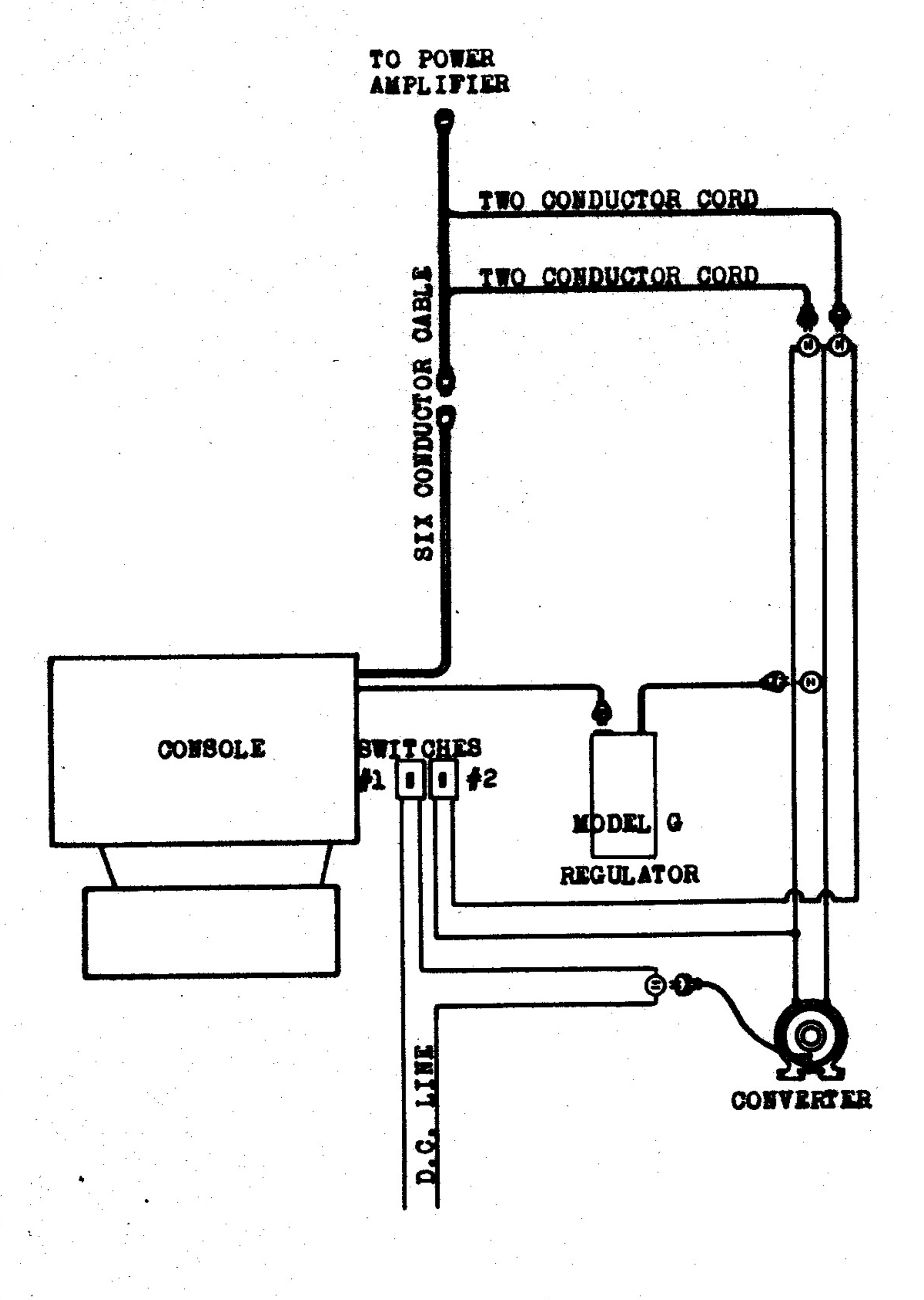

TO POWER
AMPLIFIER
TWO CONDUCTOR CORD
TWO CONDUCTOR CORD
SIX CONDUCTOR CABLE
CONSOLE
SWITCHES
#1
#2
MODEL G
REGULATOR
D.C. LINE
CONVERTER

FIGURE 4.

To start the organ when installed in this manner, the following procedures should be followed:

1. Turn on switch #1. Watch for the neon lamp on the regulator to glow.
2. Start the console in the usual manner.
3. Turn on switch #2.

A maximum of three amplifiers may be energized through the console to cabinet cable as shown. If additional cabinets are required they should be connected in the usual manner to a separate power source.

Switch #2 may be eliminated by including a special relay in series with the synchronous motors to turn on the power cabinets. Figure 7 shows this relay in use. This relay does not have sufficient current carrying capacity to control the A.C. supply to the power amplifiers directly, therefore, it is necessary to also include a type A-107 relay for this purpose.

Type 3040A5 relay manufactured by the Automatic Electric Company is used in series with the console run motors, and type A-107 manufactured by the Allen-Bradley Company is used to energize the power amplifiers.

A convenient method of providing automatic operation is to mount both relays in a box provided with the necessary fittings to connect to organ equipment and power source as shown in figure 6. This method is especially useful for demonstration work as no special wiring is necessary other than the usual changes to console line panel shown in figure 2.

Such a relay box may be located in any location most convenient for plugging in the organ equipment. A box 18 inches by 8 inches outside dimensions is a convenient size as the Model G regulator may then be placed on top of the relay box and the connections made in an orderly manner. The relay box should be at least 3 ½ inches in depth inside.

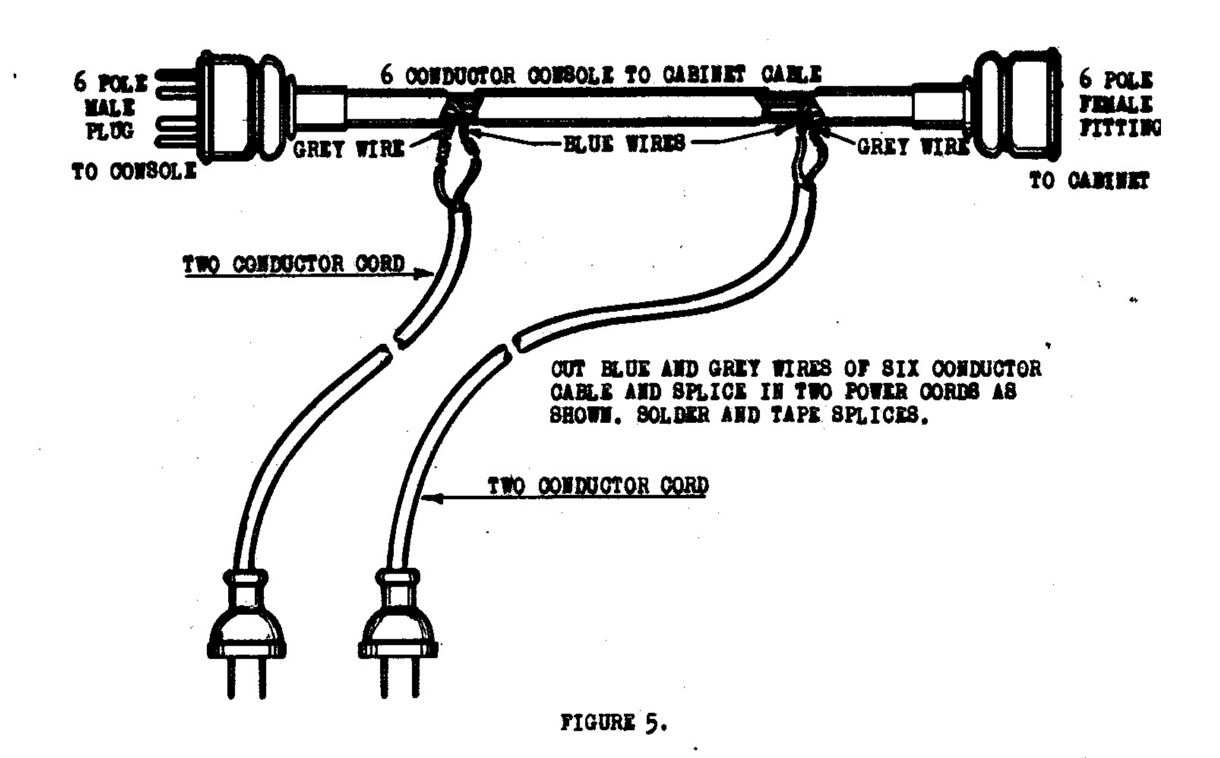


FIGURE 5.

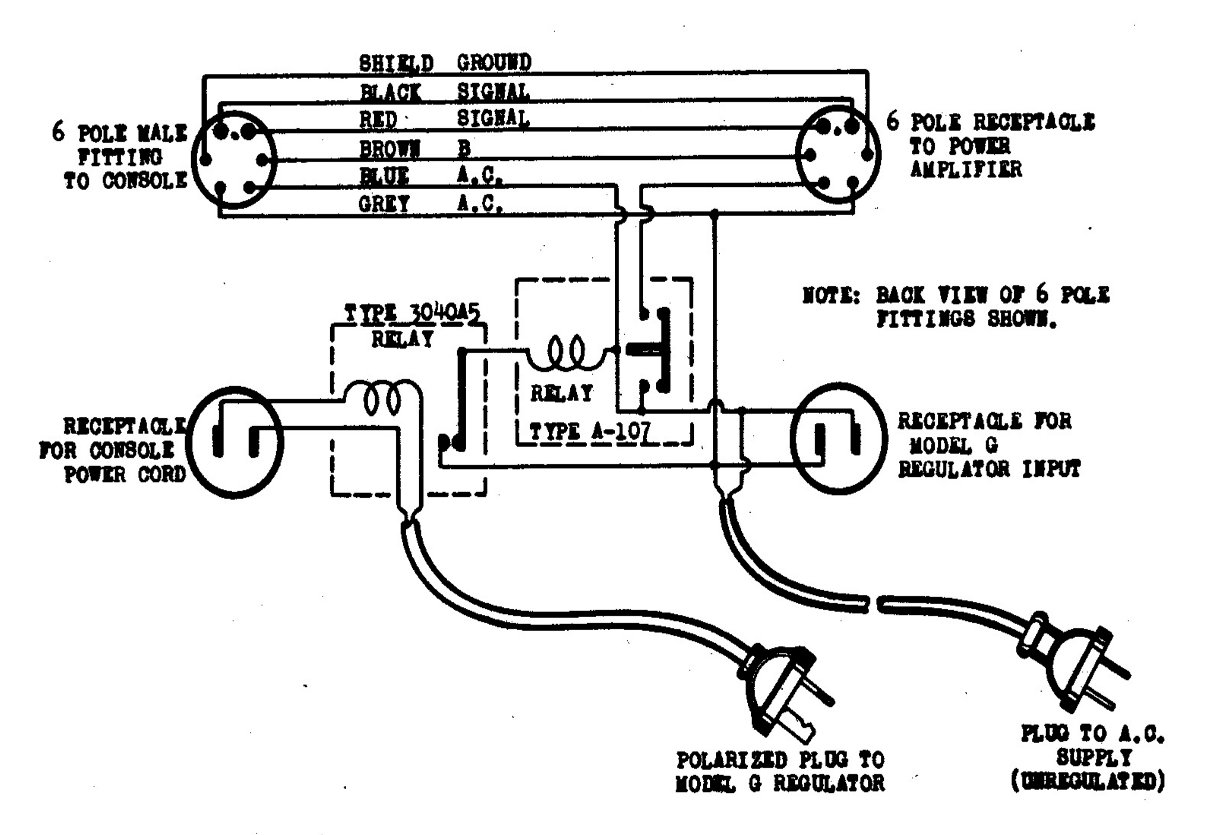


FIGURE 6.

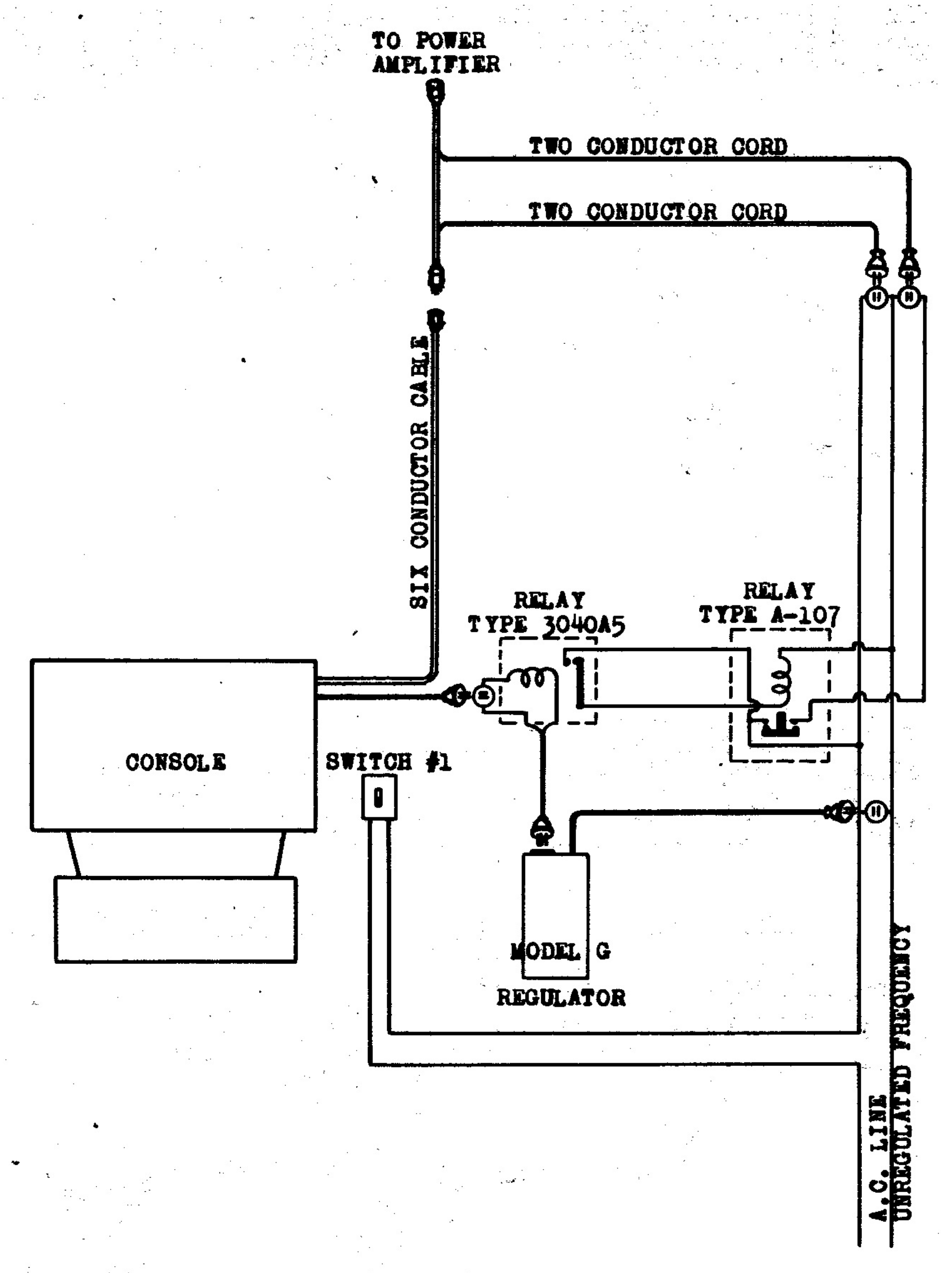
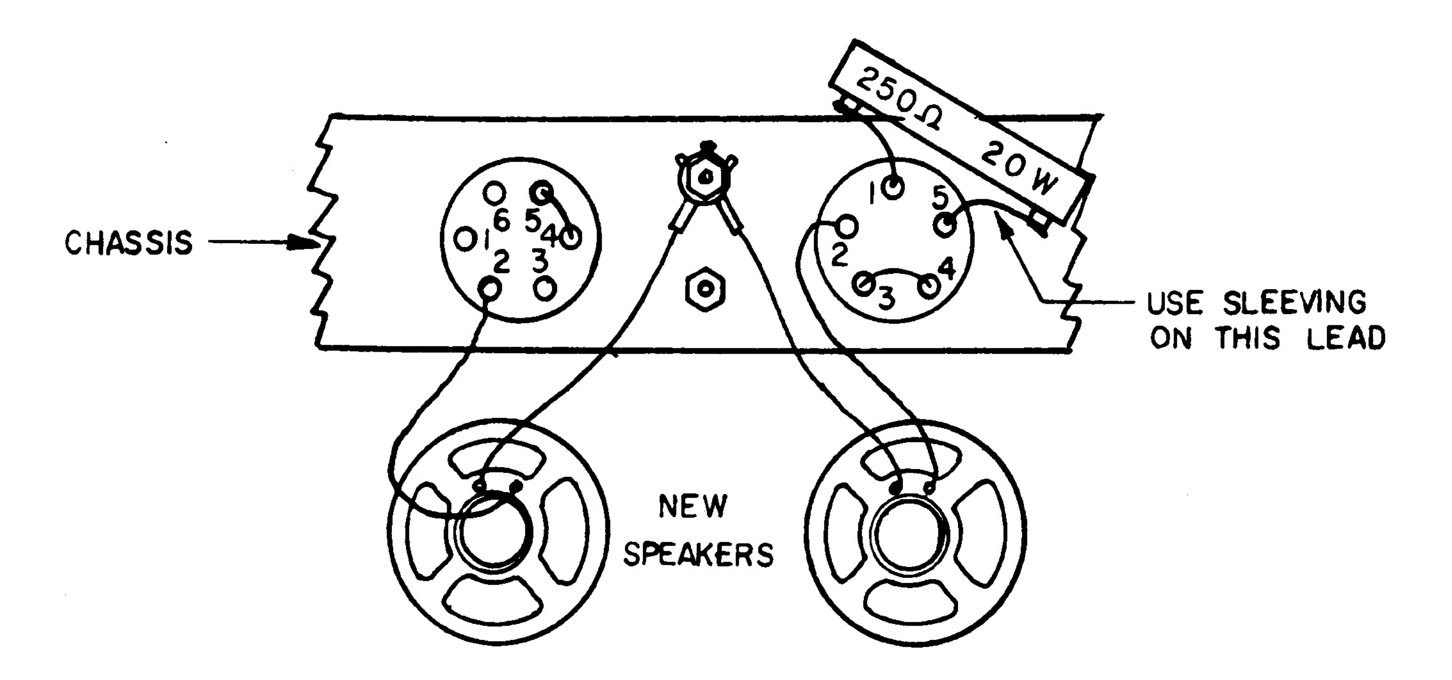

TO POWER
AMPLIFIER
TWO CONDUCTOR CORD
TWO CONDUCTOR CORD
SIX CONDUCTOR CABLE
RELAY
TYPE 3040A5
RELAY
TYPE A-107
CONSOLE
SWITCH #1
MODEL G
REGULATOR
A.C. LINE
UNREGULATED FREQUENCY

FIGURE 7.

SPEAKER REPLACEMENT IN EARLY TONE CABINETS USING ELECTRODYNAMIC SPEAKERS



Electrodynamic speakers are no longer being manufactured. They can be replaced with Permanent Magnet (PM) speakers in early Hammond tone cabinets. Good results will be achieved, if the instructions on the next page are followed.

1. Remove speaker plugs from amplifier and remove both speakers from tone cabinet.

2. Clip all 4 wires from both speakers as close to speaker as possible.

3. Discard both speakers.

4. Remove wires from pins 1 and 6 of the 6 pole plug. Remove these wires from cable.

5. Remove wires from pins 1 and 5 of the 5 pole plug. Remove these wires from cable.

6. Install a 250 ohm 20 watt resistor across pins 1 and 5 of the 5 pole plug. Use sleeving over lead connected to pin 5.

7. Solder 2 remaining wires in each speaker cable to the new PM speakers. Solder wire with solder lug to the left hand speaker terminal as viewed with the speaker terminal strip facing up. Solder wire from speaker plug to right hand terminal.

8. Mount new speakers in cabinet and insert plugs into amplifier. Attach leads with solder lug to upper binding post.

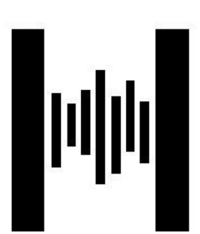
9. Dress 250 ohm resistor away from any speaker leads or other objects to assure adequate heat dissipation.

THE HAMMOND ORGAN

– 16 –

WIRING & SCHEMATIC
DIAGRAMS

PART 1 - CONSOLE DIAGRAMS



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

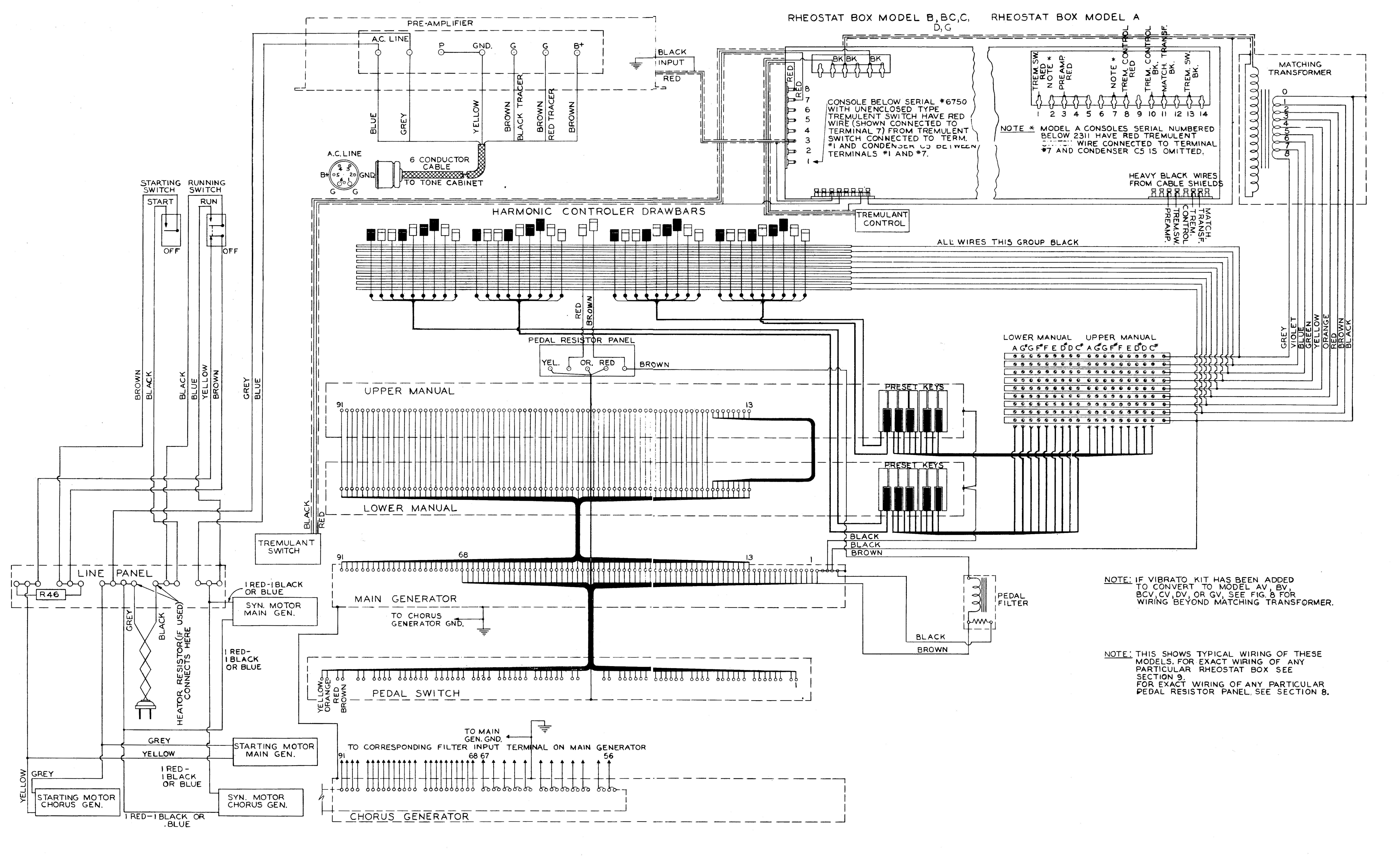


FIG. 15 WIRING DIAGRAM
CONSOLE MODEL A,B,BC,C,D,G

CHORUS GENERATOR
FREQUENCIES FROM 56 THRU 91

MULTI-CONTACT SWITCH

FREQUENCIES 56 THRU 67 USE TWO SEPARATE CHORUS MAGNETS AND WHEELS PER NOTE.

GENERATORS 49-91 USE THIS CIRCUIT

GENERATORS 44-46 USE THIS CIRCUIT

GENERATORS 1-43 USE THIS CIRCUIT

GENERATOR OUTPUT TERMINALS

MAIN TONE GENERATOR ASSEMBLY

NINE BUSBARS IN DRAWBAR ASSEMBLY

TYPICAL GROUP OF LOWER MANUAL DRAWBARS

PEDAL DRAWBARS

TYPICAL GROUP OF UPPER MANUAL DRAWBARS

MATCHING TRANSFORMER

TO GENERATOR TERMINALS (SEE MANUAL WIRING CHART)

BUSBARS

NINE CONTACTS UNDER TYPICAL PLAYING KEY

NINE CONTACTS UNDER TYPICAL ADJUST KEY

NINE CONTACTS UNDER CONTACTS PRESET KEY

UPPER MANUAL

PRESET PANEL

NINE CONTACTS UNDER TYPICAL PRESET KEY

LOWER MANUAL

8 CONTACTS UNDER TYPICAL PEDAL KEY (7 IN EARLIER MODELS)

TO GENERATOR TERMINALS (SEE PEDAL WIRING CHART)

THESE TWO RESISTORS OMITTED IN EARLIER MODELS

SWELL RHEOSTAT

LOUD ←→ SOFT

1.3 MEGOHM TREMULANT CONTROL

OPENS FIRST

OPENS LAST

TREMULANT SWITCH

TONE CONTROL

PREAMP. HEATERS 2.5V

P GND.

REVERBERATION AMP. HEATERS 6.3V.

T3

REVERBERATION UNIT

DRIVER

CRYSTAL

1ST SECTION OF REVERBERATION AMPLIFIER (IN TONE CABINET)

2ND SETION OF REVERBERATION AMPLIFIER (IN TONE CABINET)

COUPLING TRANSFORMER

DRIVE FOR ADDITIONAL AMPLIFIERS

OUTPUT TRANSF.

VOICE COILS 8 OHMS EACH

R.F. CHOKES

SPKR. FIELD 5000Ω

FILTER CHOKES

SPK. FLD. 250Ω

POWER TRANSFORMER

SWITCH AND MOTOR CIRCUITS

RUIN SWITCH

OFF ON

START SWITCH

STARTING MOTOR

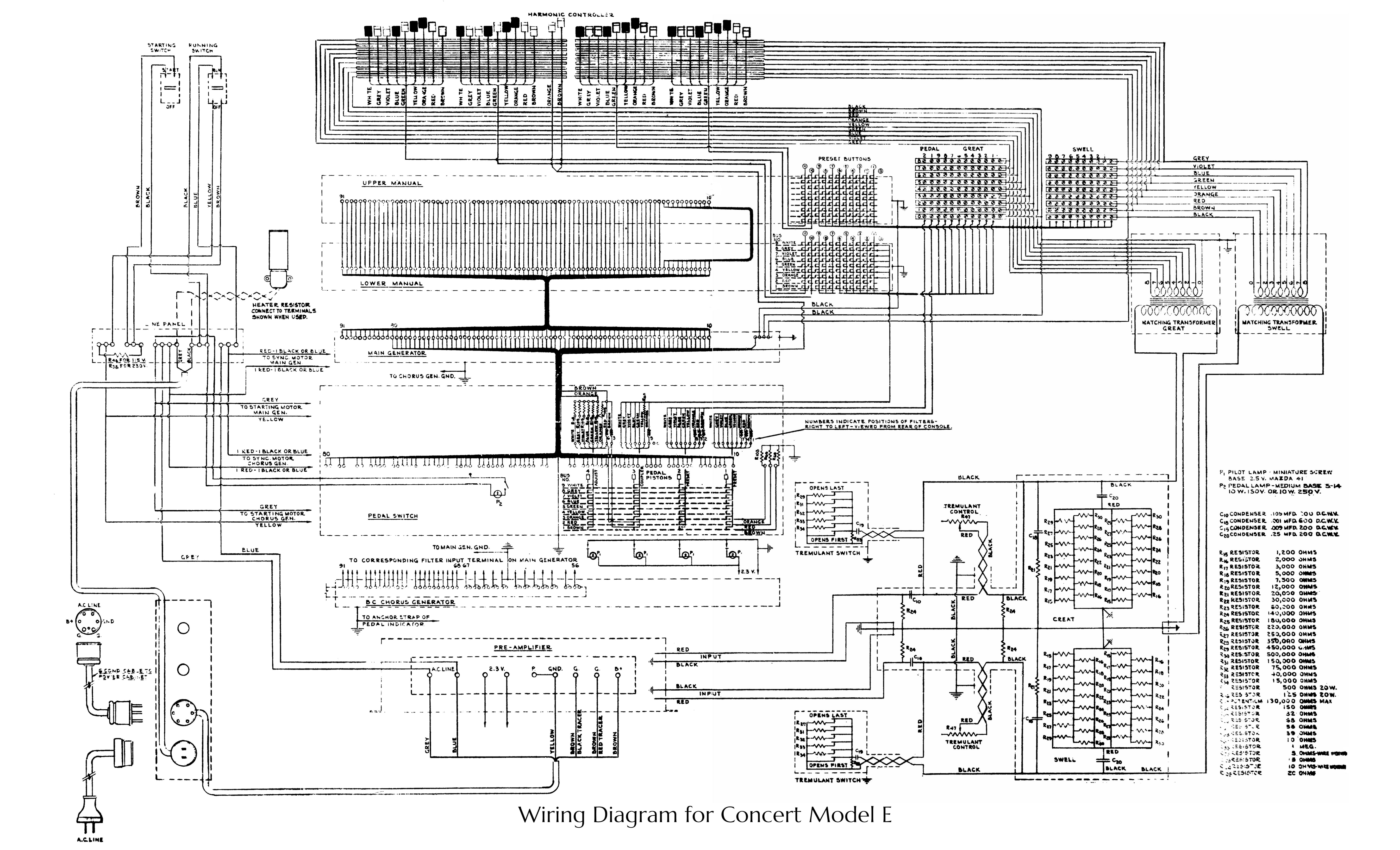
SYNCHRONOUS MOTOR

POWER AMPLIFIER (IN TONE CABINET)

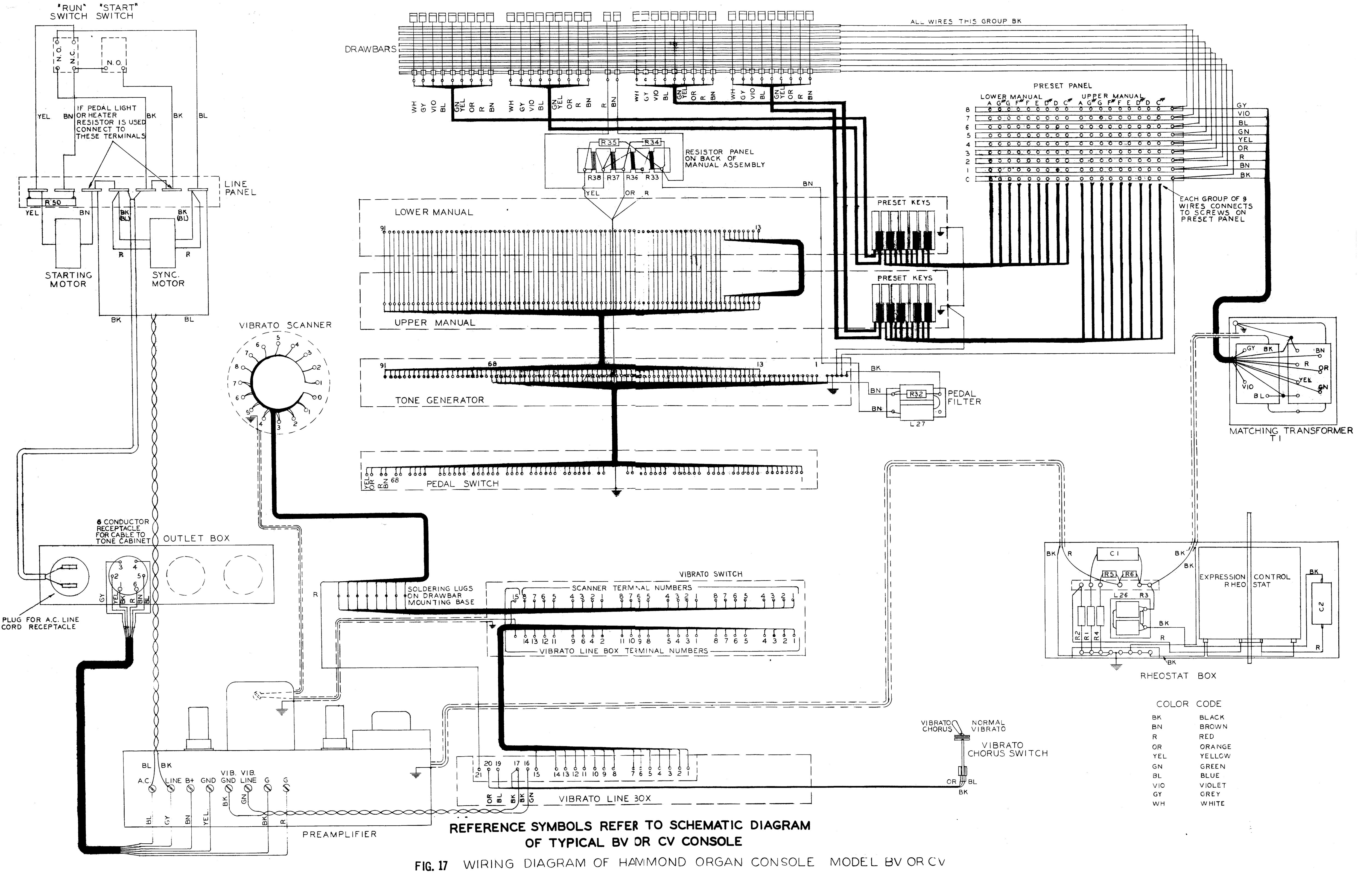
NOTE: IF VIBRATO KIT HAS BEEN ADDED TO CONVERT TO MODEL AV, BV, BCV, CV, DV, OR GV, SEE FIG. 9 FOR CIRCUIT BEYOND MATCHING TRANSFORMER.

NOTE: THIS IS TYPICAL CIRCUIT OF THESE MODELS. FOR EXACT WIRING OF PREAMPLIFIER SEE SECTION 11. FOR EXACT WIRING OF RHEOSTAT BOX, SEE SECTION 9. FOR EXACT WIRING OF PEDAL CIRCUITS, SEE SECTION 8.

FIG. 16 - SCHEMATIC DIAGRAM OF TYPICAL HAMMOND ORGAN MODEL A, B, BC, C, D, AND G WITH DR-20 OR ER-20 TONE CABINET



Wiring Diagram for Concert Model E



REFERENCE SYMBOLS REFER TO SCHEMATIC DIAGRAM OF TYPICAL BV OR CV CONSOLE

FIG. 17 WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL BV OR CV

MAIN TONE GENERATOR ASSEMBLY

GENERATORS 49-91 USE THIS CIRCUIT

GENERATORS 44-48 USE THIS CIRCUIT

GENERATORS 1-43 USE THIS CIRCUIT

GENERATOR OUTPUT TERMINALS

NINE BUSBARS IN DRAWBAR ASSEMBLY

TYPICAL GROUP OF LOWER MANUAL DRAWBARS

PEDAL DRAWBARS

TYPICAL GROUP OF UPPER MANUAL DRAWBARS

TO GENERATOR TERMINALS (SEE MANUAL WIRING CHART)

BUSBARS

NINE CONTACTS UNDER TYPICAL PLAYING KEY

NINE CONTACTS UNDER TYPICAL ADJUST KEY

NINE CONTACTS UNDER TYPICAL PRESET KEY

UPPER MANUAL

PRESET PANEL

LOWER MANUAL

TO GENERATOR TERMINALS (SEE PEDAL WIRING CHART)

8 CONTACTS UNDER TYPICAL PEDAL KEY

PEDAL SWITCH

RHEOSTAT BOX

MATCHING TRANSFORMER T1

EXPRESSION CONTROL

CONNECTION FOR INCREASED OUTPUT

CONNECTION FOR DECREASED OUTPUT

FIRST SECTION OF PREAMPLIFIER

"HI IMP. INPUT"

TERMINAL GROUNDED BY JUMPER WHEN NOT IN USE

VIBRATO LINE TRANSFORMER

SECOND SECTION OF PREAMPLIFIER

SCANNER

PREAMP. OUTPUT TRANSFORMER

THESE CONTACTS CLOSE IN POSITION 2

THIS CONTACT CLOSED IN VIBRATO "OFF" POSITIONS

THESE CONTACTS CLOSE IN POSITION 1

THESE CONTACTS CLOSE IN POSITION 3

VIBRATO SWITCH

VIBRATO CHORUS

NORMAL VIBRATO

VIBRATO PHASE SHIFT LINE

SWITCH AND MOTOR CIRCUITS

"RUN" SWITCH

"START" SWITCH

STARTING MOTOR

SYNCHRONOUS MOTOR

POWER SUPPLY

5000 OHM SPEAKER FIELD

250 OHM SPEAKER FIELD

6.3V HEATERS V6, V7, V8, V9, V10, V11, V12

PREAMPLIFIER HEATER TRANSFORMER

TO V3 & V5 CATHODES

REVERBERATION UNIT

REVERBERATION OUTPUT TRANSFORMER

DRIVER

CRYSTAL

OUTPUT TRANSFORMER T7

VOICE COILS 8 OHMS EACH

TYPICAL POWER AMPLIFIER TYPE HR (IN TONE CABINET)

FIG. 18 SCHEMATIC DIAGRAM OF TYPICAL HAMMOND ORGAN MODEL BV OR CV WITH DR-20 OR ER-20 TONE CABINET

(MODEL RT USES THIS CIRCUIT BUT HAS PEDAL SOLO UNIT ADDED)

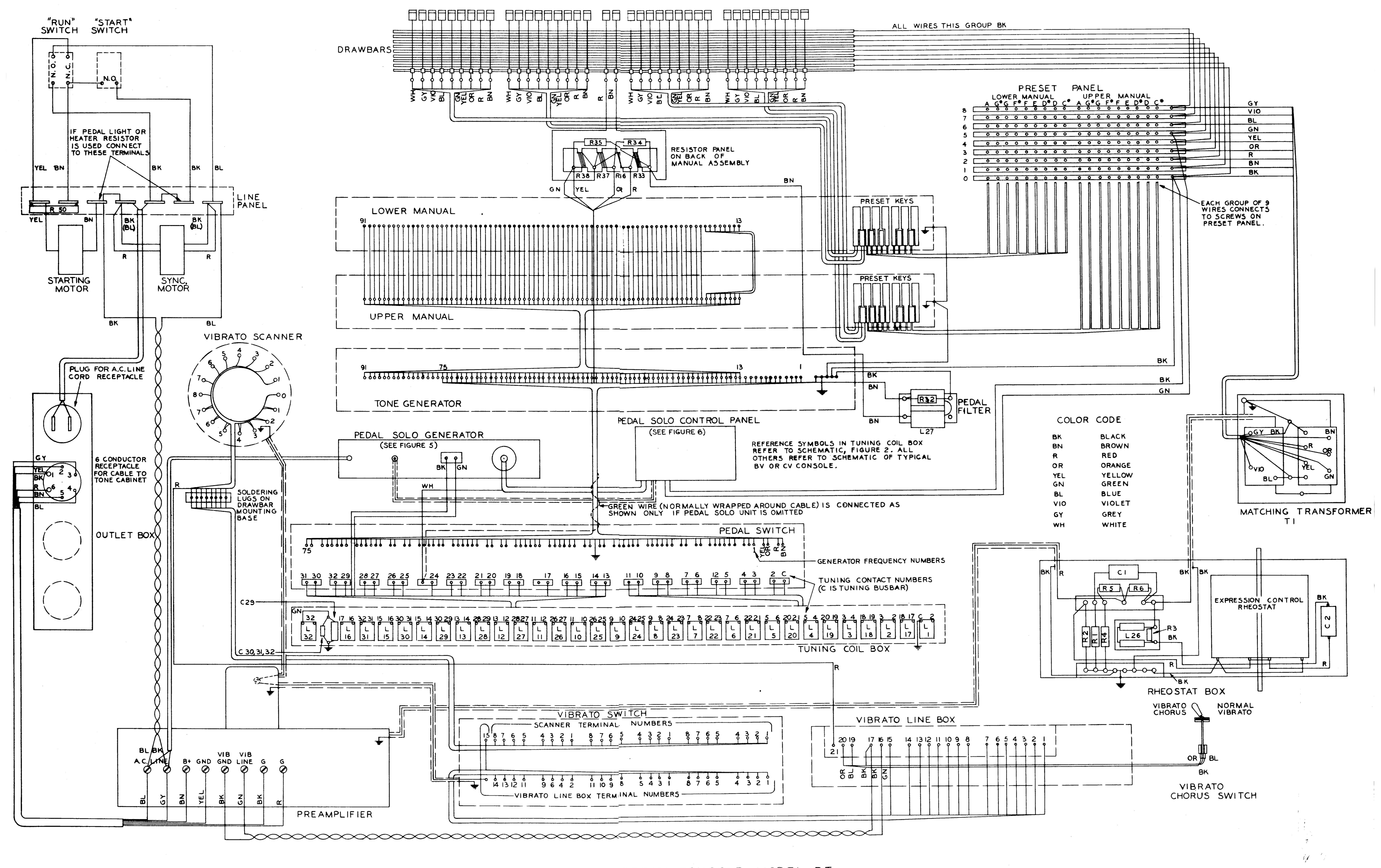


FIG. 19 -WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL RT

"RUN" SWITCH

"START" SWITCH

IF PEDAL LIGHT OR HEATER RESISTOR IS USED CONNECT TO THESE TERMINALS

LINE PANEL

STARTING MOTOR

SYNC. MOTOR

DRAWBARS

RESISTOR PANEL ON BACK OF MANUAL ASSEMBLY

PEDAL FILTER

LOWER MANUAL

UPPER MANUAL

PRESET KEYS

LOWER MANUAL PRESET PANEL

UPPER MANUAL PRESET PANEL

EACH GROUP OF NINE WIRES CONNECTS TO SCREWS ON PRESET PANEL

VIBRATO SCANNER

TONE GENERATOR

PEDAL SWITCH

MATCHING TRANSFORMERS

T1 (LOWER MANUAL)

T2 (UPPER MANUAL)

5 CONDUCTOR RECEPTACLE FOR CABLE TO TONE CABINET

OUTLET BOX

TERMINAL LUGS ON DRAWBAR MOUNTING BASE

VIBRATO SWITCH

SCANNER TERMINAL NUMBERS

VIBRATO LINE BOX TERMINAL NUMBERS

PREAMPLIFIER

AC LINE

GND

TONE CONTROL

VOL

SW

VIB LINE

SCAN

NO VIB

VIB

VIBRATO LINE BOX

CONTROL PANEL (REAR VIEW WITH COVER REMOVED)

COLOR CODE

BK	BLACK
BN	BROWN
R	RED
OR	ORANGE
YEL	YELLOW
GN	GREEN
BL	BLUE
VIO	VIOLET
GY	GREY
WH	WHITE
B	BARE

REFERENCE SYMBOLS REFER TO SCHEMATIC DIAGRAM OF ORGAN MODEL B2 - C2

FIG. 20 WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL B-2 OR C-2

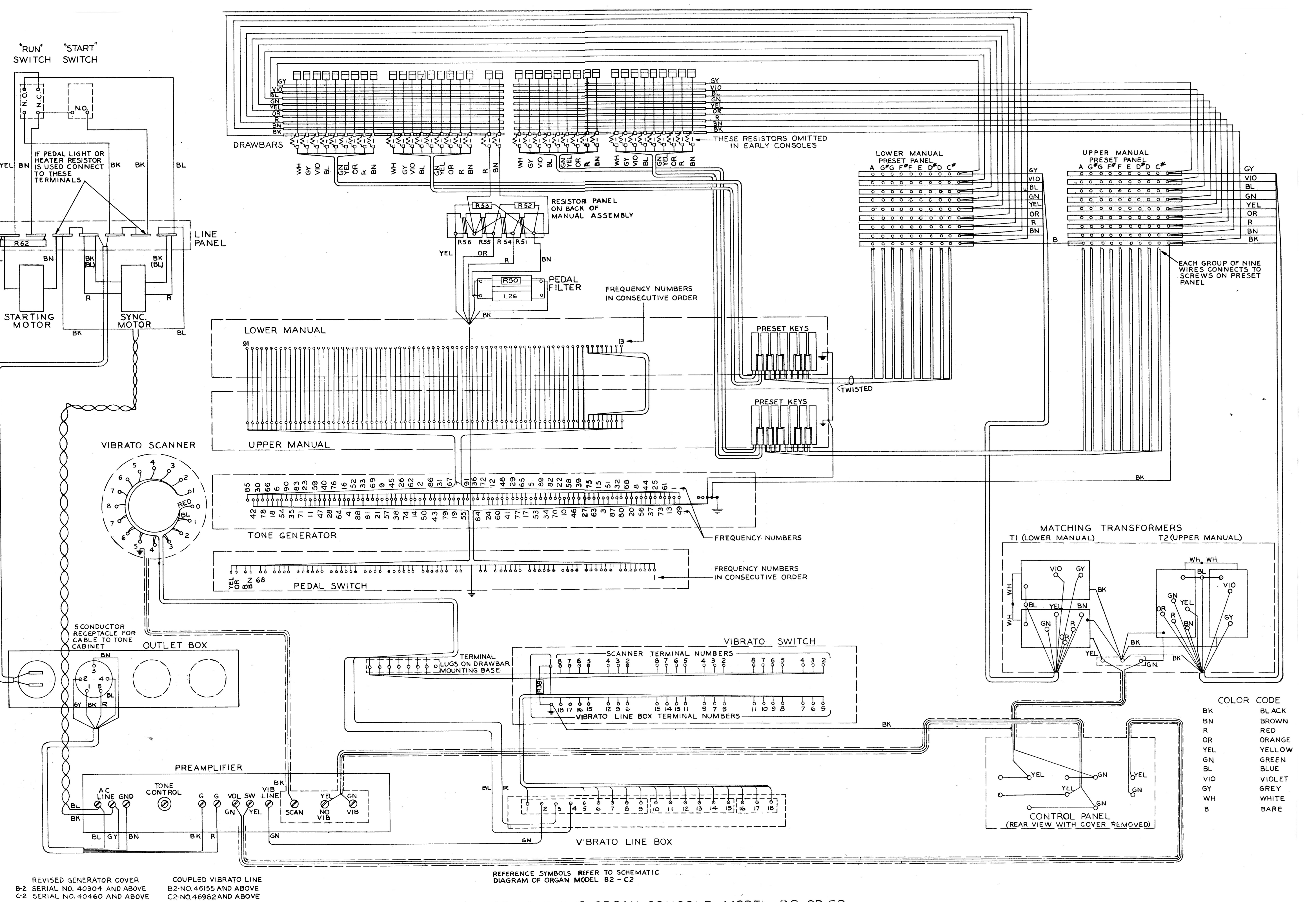


FIGURE 20A– WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL B-2 OR C-2

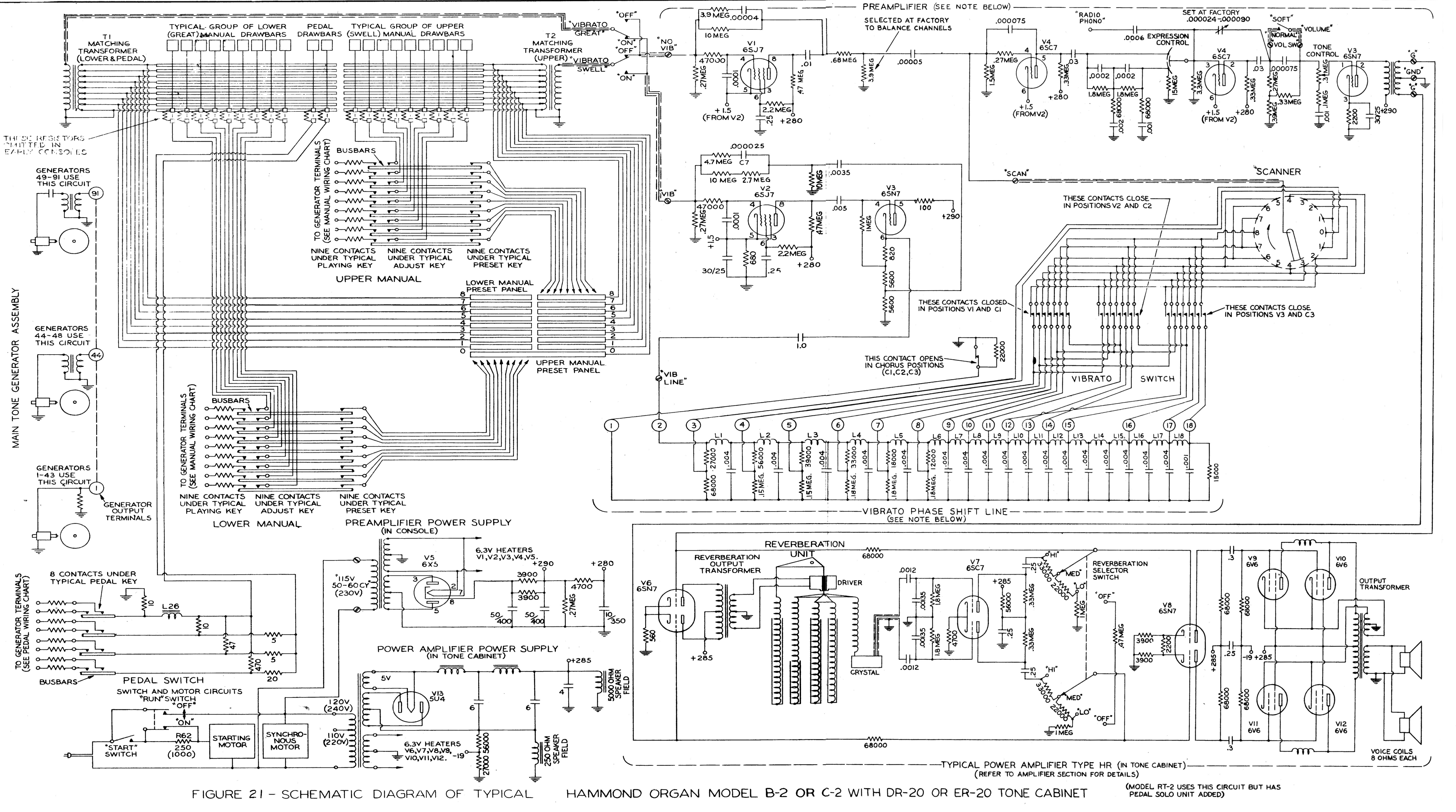
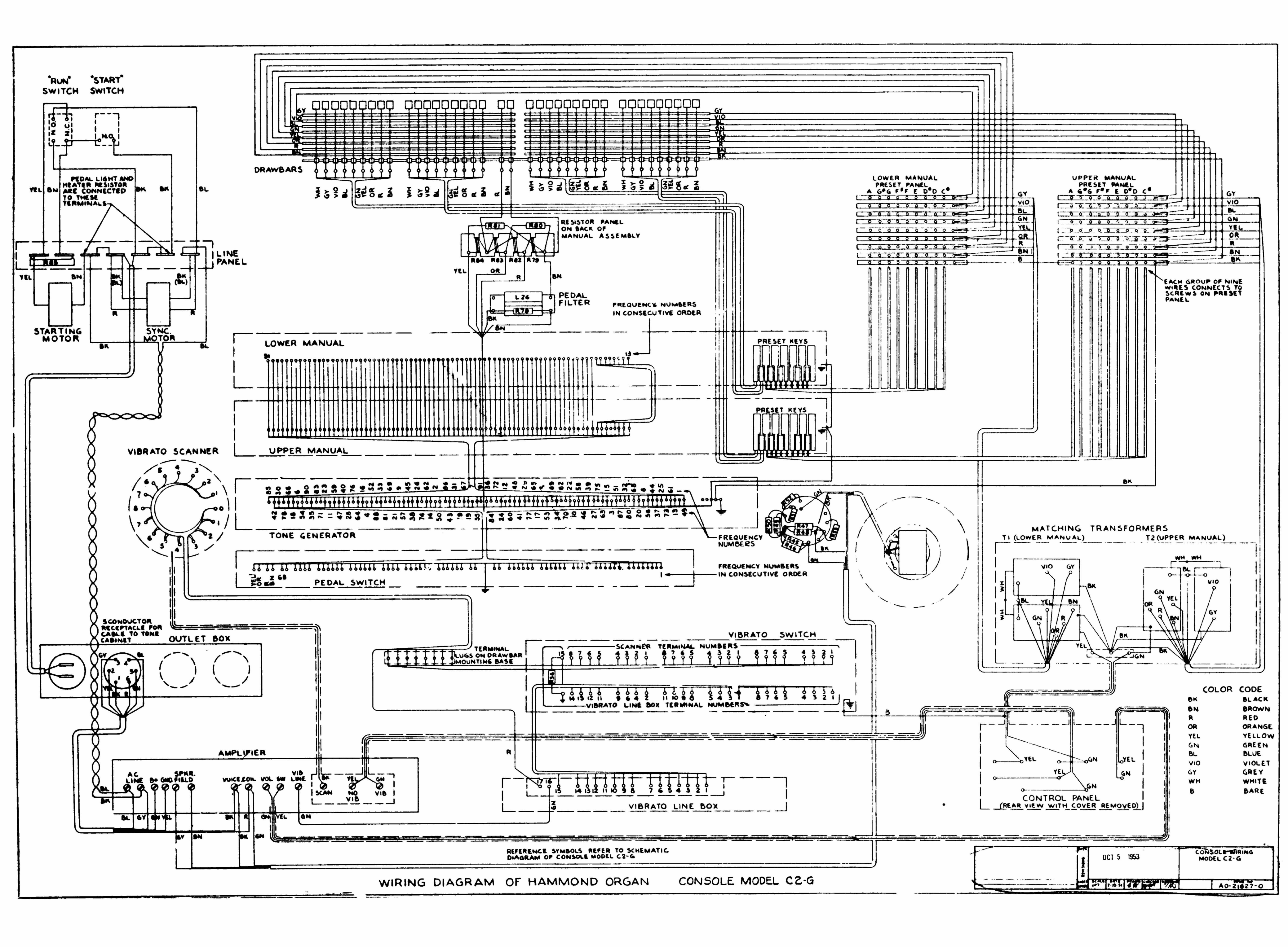


FIGURE 21 - SCHEMATIC DIAGRAM OF TYPICAL HAMMOND ORGAN MODEL B-2 OR C-2 WITH DR-20 OR ER-20 TONE CABINET

(MODEL RT-2 USES THIS CIRCUIT BUT HAS PEDAL SOLO UNIT ADDED)

NOTE: THIS SHOWS CIRCUIT OF TYPICAL ORGAN OF THESE MODELS. FOR EXACT CIRCUIT OF ANY PARTICULAR PREAMPLIFIER OR POWER AMPLIFIER, SEE AMPLIFIER SECTION OF SERVICE MANUAL. FOR EXACT VIBRATO CIRCUIT OF ANY PARTICULAR CONSOLE, SEE VIBRATO SECTION OF SERVICE MANUAL.



WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL C2-G

C2-G Schematic

T1 MATCHING TRANSFORMER (LOWER & PEDAL)
TYPICAL GROUP OF LOWER (GREAT) MANUAL DRAWBARS
PEDAL DRAWBARS
TYPICAL GROUP OF UPPER (SWELL) MANUAL DRAWBARS
T2 MATCHING TRANSFORMER (UPPER)
"VIBRATO GREAT" "OFF" "ON"
"VIBRATO SWELL" "OFF" "ON"
"NO VIB"
"VIB"
TONE GENERATOR ASSEMBLY
GENERATORS 49-91 USE THIS CIRCUIT
GENERATORS 44-48 USE THIS CIRCUIT
GENERATORS 1-43 USE THIS CIRCUIT
GENERATOR OUTPUT TERMINALS
BUSBARS
TO GENERATOR TERMINALS (SEE MANUAL WIRING CHART)
NINE CONTACTS UNDER TYPICAL PLAYING KEY
NINE CONTACTS UNDER TYPICAL ADJUST KEY
NINE CONTACTS UNDER TYPICAL PRESET KEY
UPPER MANUAL
LOWER MANUAL
LOWER MANUAL PRESET PANEL
UPPER MANUAL PRESET PANEL
8 CONTACTS UNDER TYPICAL PEDAL KEY
TO GENERATOR TERMINALS (SEE PEDAL WIRING CHART)
PEDAL SWITCH
SELECTED AT FACTORY TO BALANCE CHANNELS
"SCAN"
"VIB LINE"
SCANNER
"SOFT" "NORMAL" "VOL SW" "VOLUME"
EXPRESSION CONTROL
LOUD SOFT
"RADIO PHONO"
C25 (SET AT FACTORY)
B+ WIRE FROM TONE CABINET
"VOICE COIL" "GND" "VOICE COIL"
T3 OUTPUT TRANSFORMER
SPEAKER VOICE COIL 8 OHMS
LOUD SOFT
SPEAKER VOLUME SWITCH
THESE CONTACTS CLOSED IN POSITIONS V1 AND C1
THESE CONTACTS CLOSE IN POSITIONS V3 AND C3
THESE CONTACTS CLOSE IN POSITIONS V2 AND C2
THIS CONTACT OPENS IN CHORUS POSITIONS C1, C2, C3
VIBRATO SWITCH
VIBRATO PHASE SHIFT LINE
"RUN" SWITCH "OFF" "ON"
"START" SWITCH
R85 250 (1000 FOR 240V)
STARTING MOTOR
SYNCHRONOUS MOTOR
"AC LINE"
6.3V HEATERS
T4 POWER TRANSFORMER
V7 5U4
"SPEAKER FIELD" 700 OHMS
EXPRESSION CONTROL
TOP VIEW OF AMPLIFIER
T4 V7 C59 V6 T3 V5 V3 V4 V2 C61 C62 V1

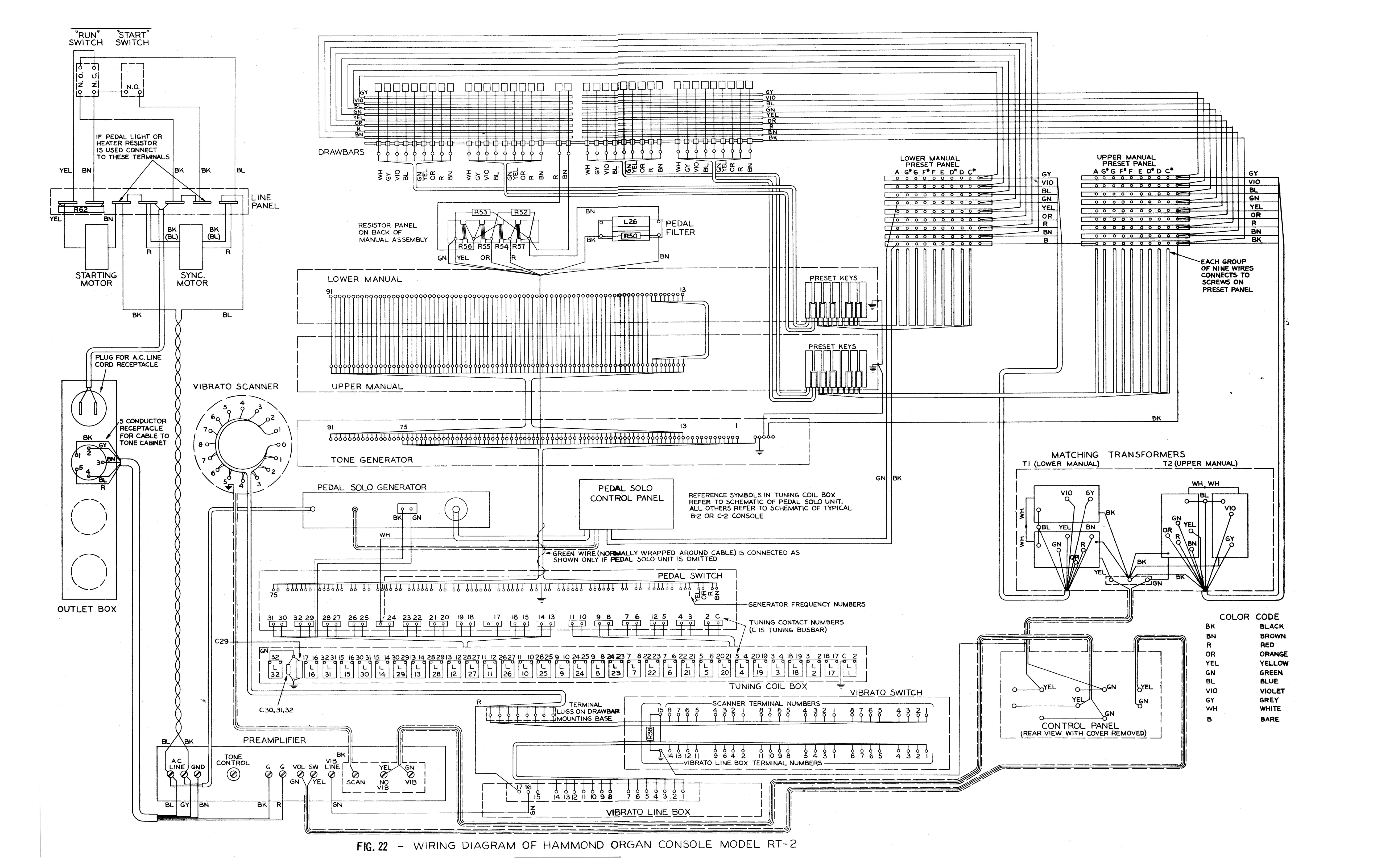


FIG. 22 – WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL RT-2

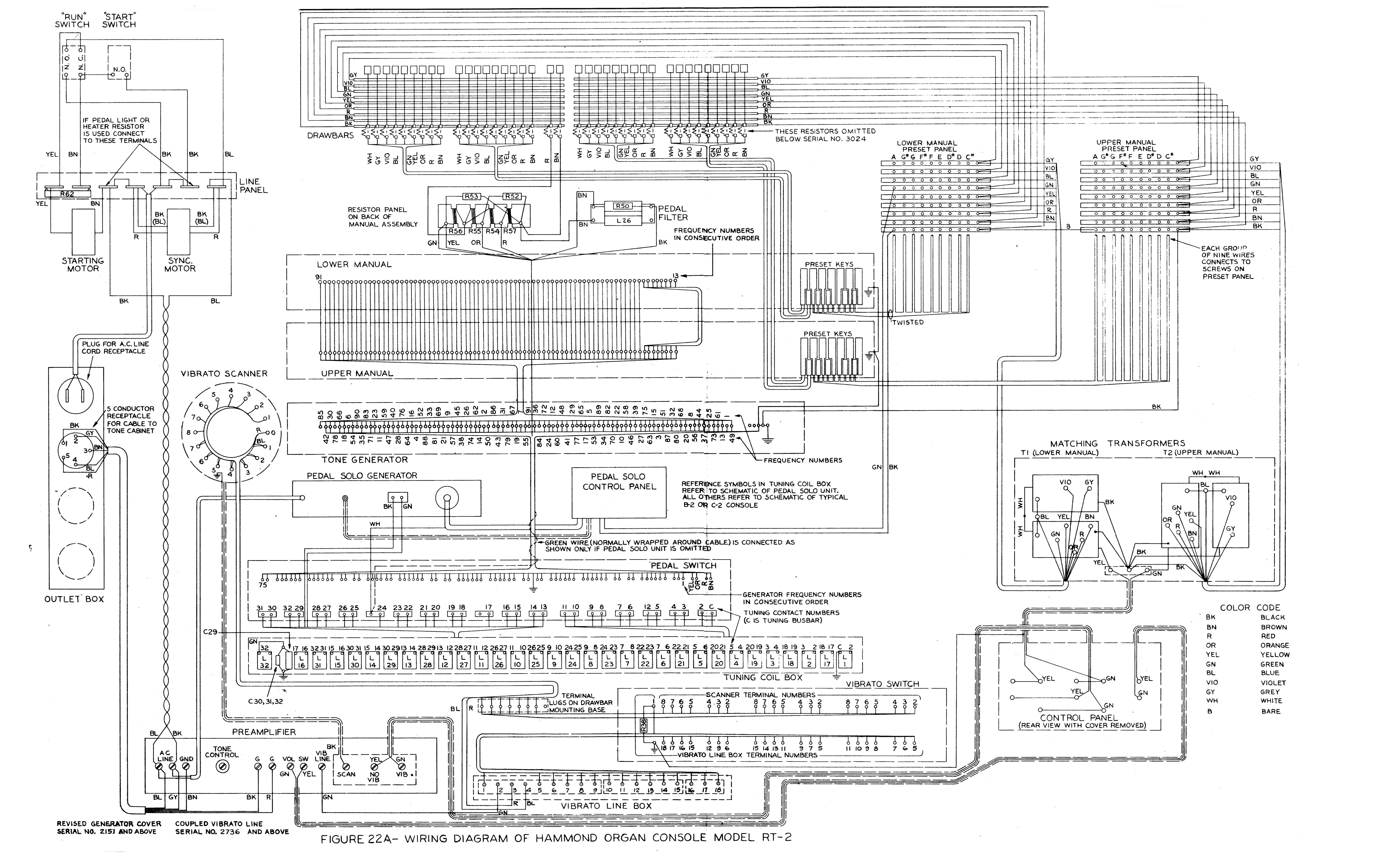


FIGURE 22A- WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL RT-2

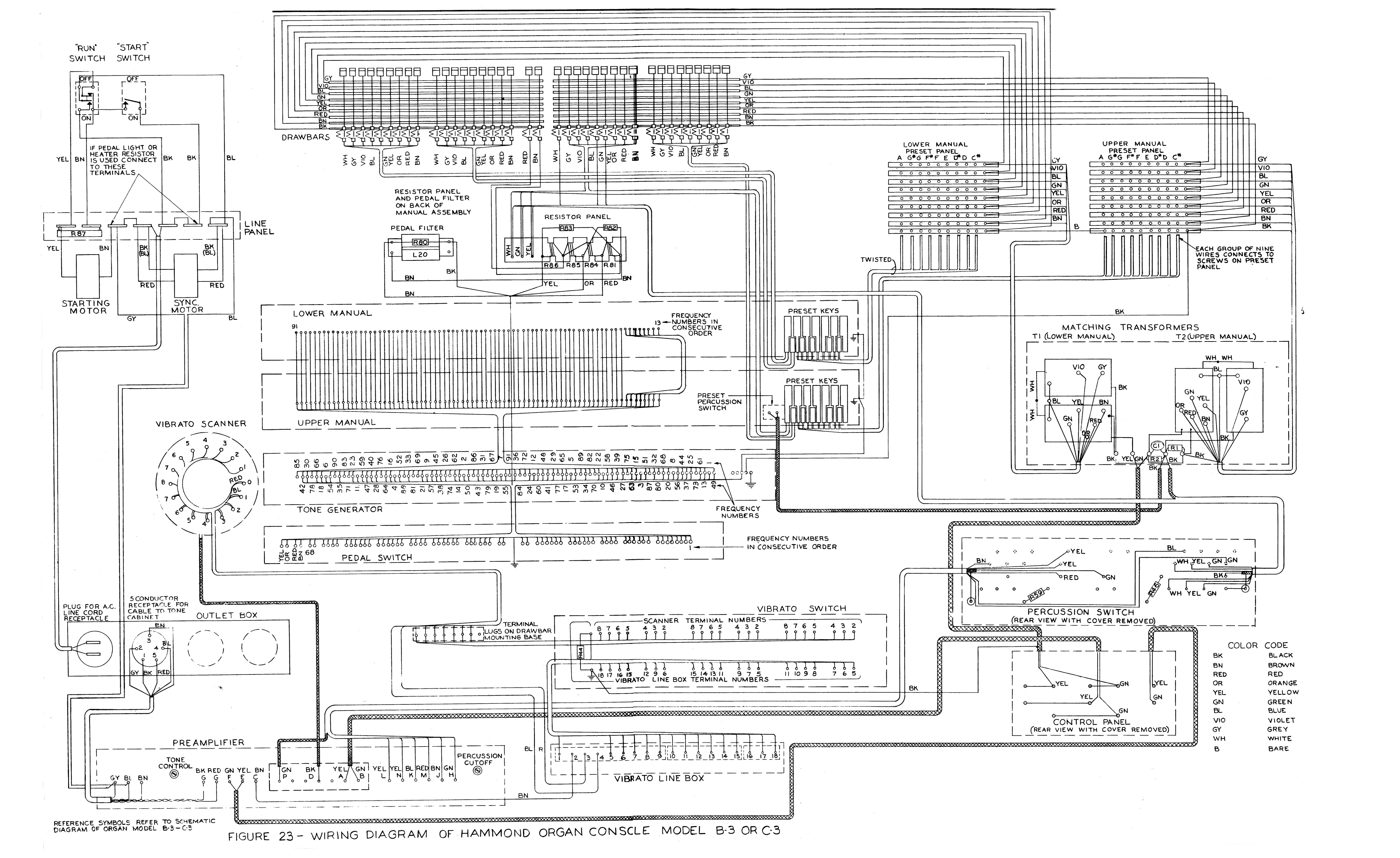


FIGURE 23 - WIRING DIAGRAM OF HAMMOND ORGAN CONSCLE MODEL B-3 OR C-3

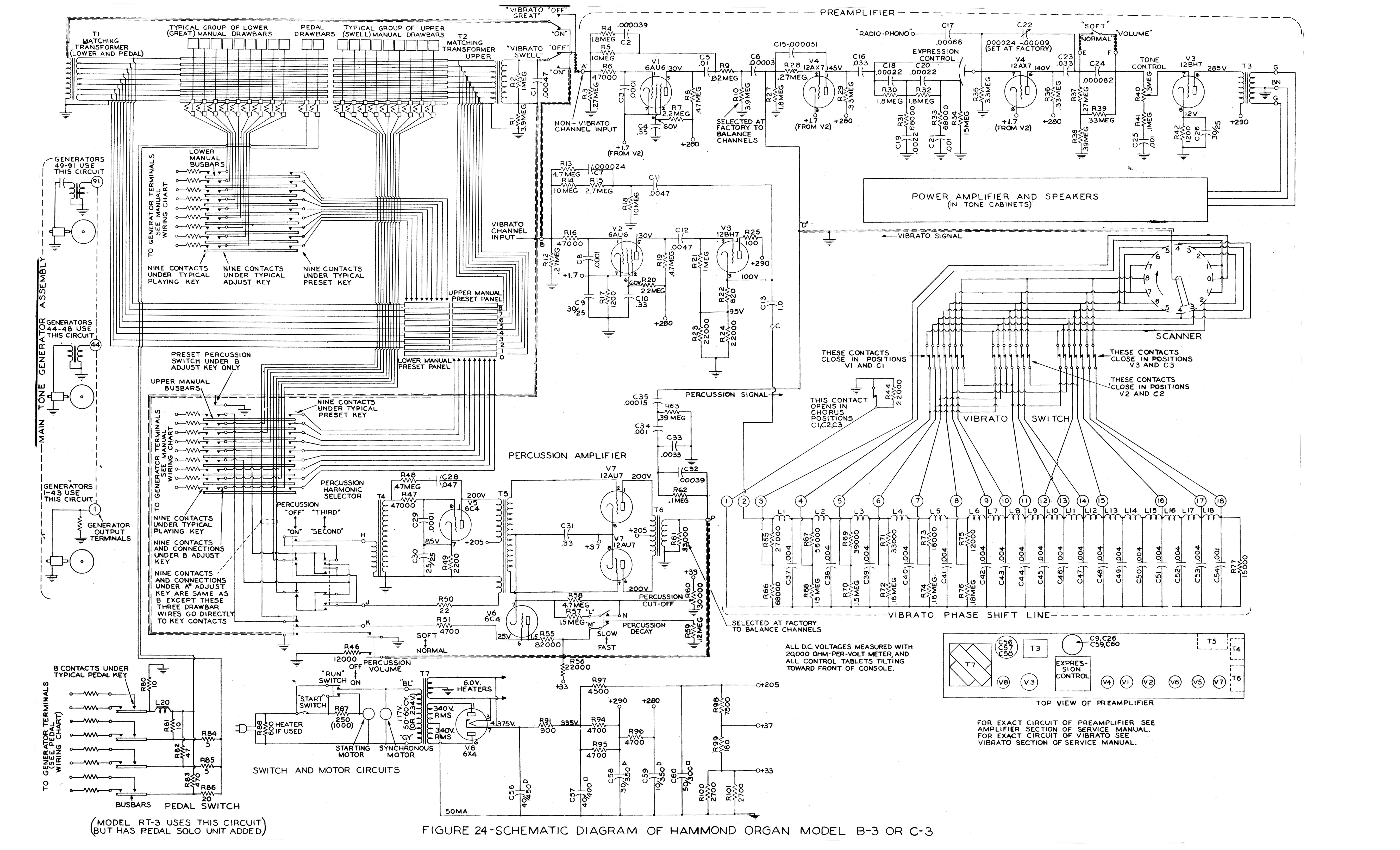


FIGURE 24-SCHEMATIC DIAGRAM OF HAMMOND ORGAN MODEL B-3 OR C-3

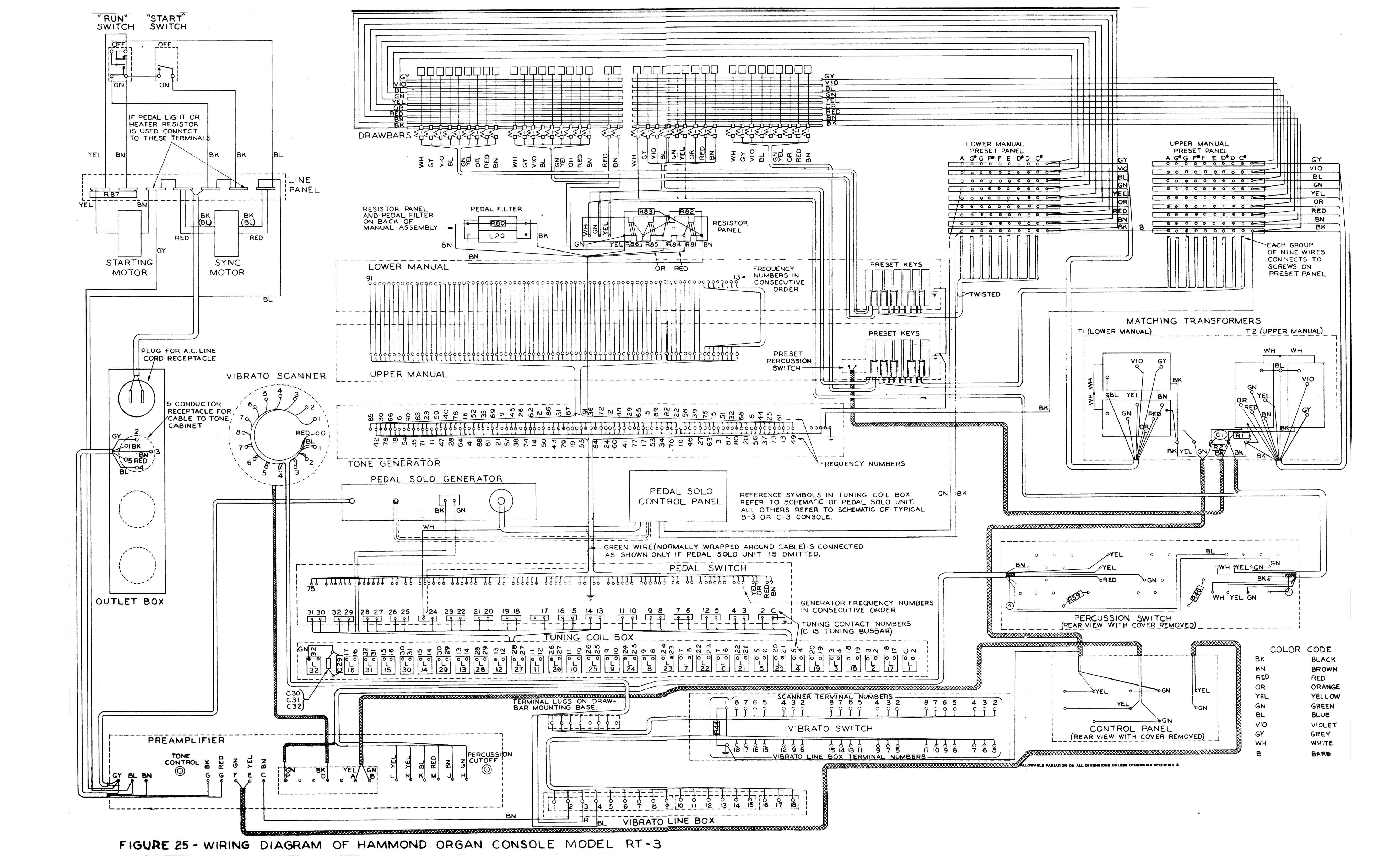


FIGURE 25 - WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL RT-3

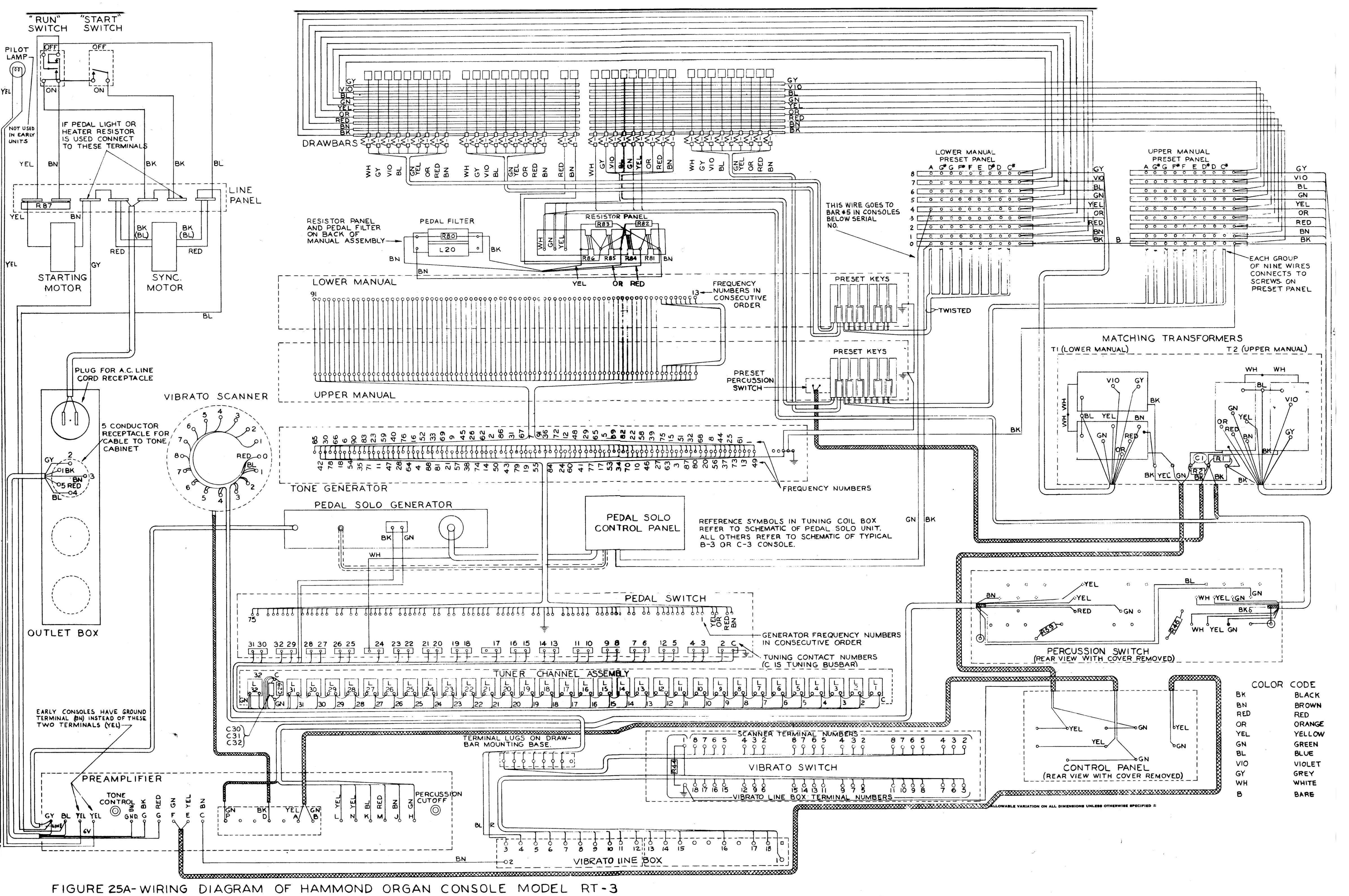
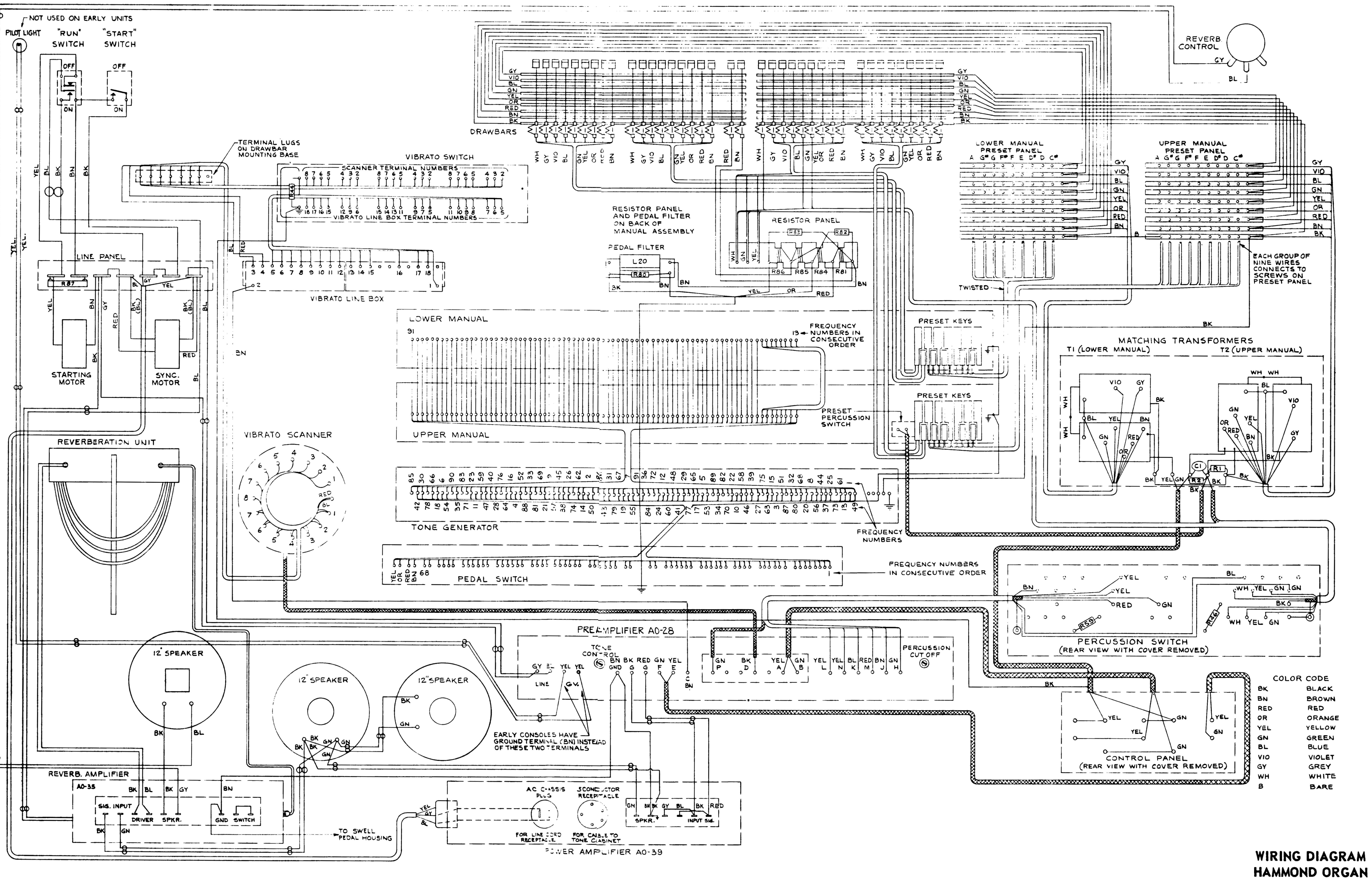
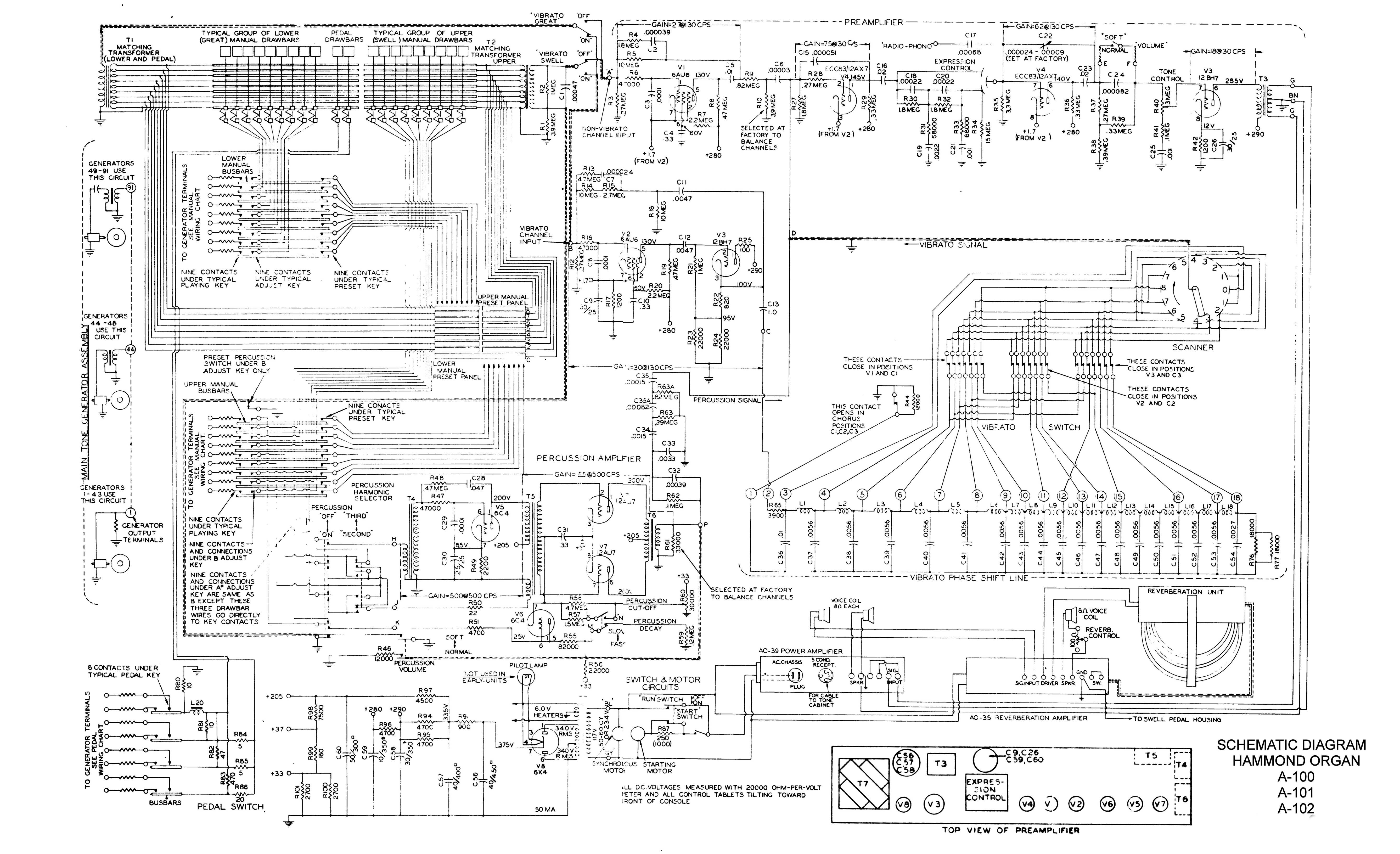


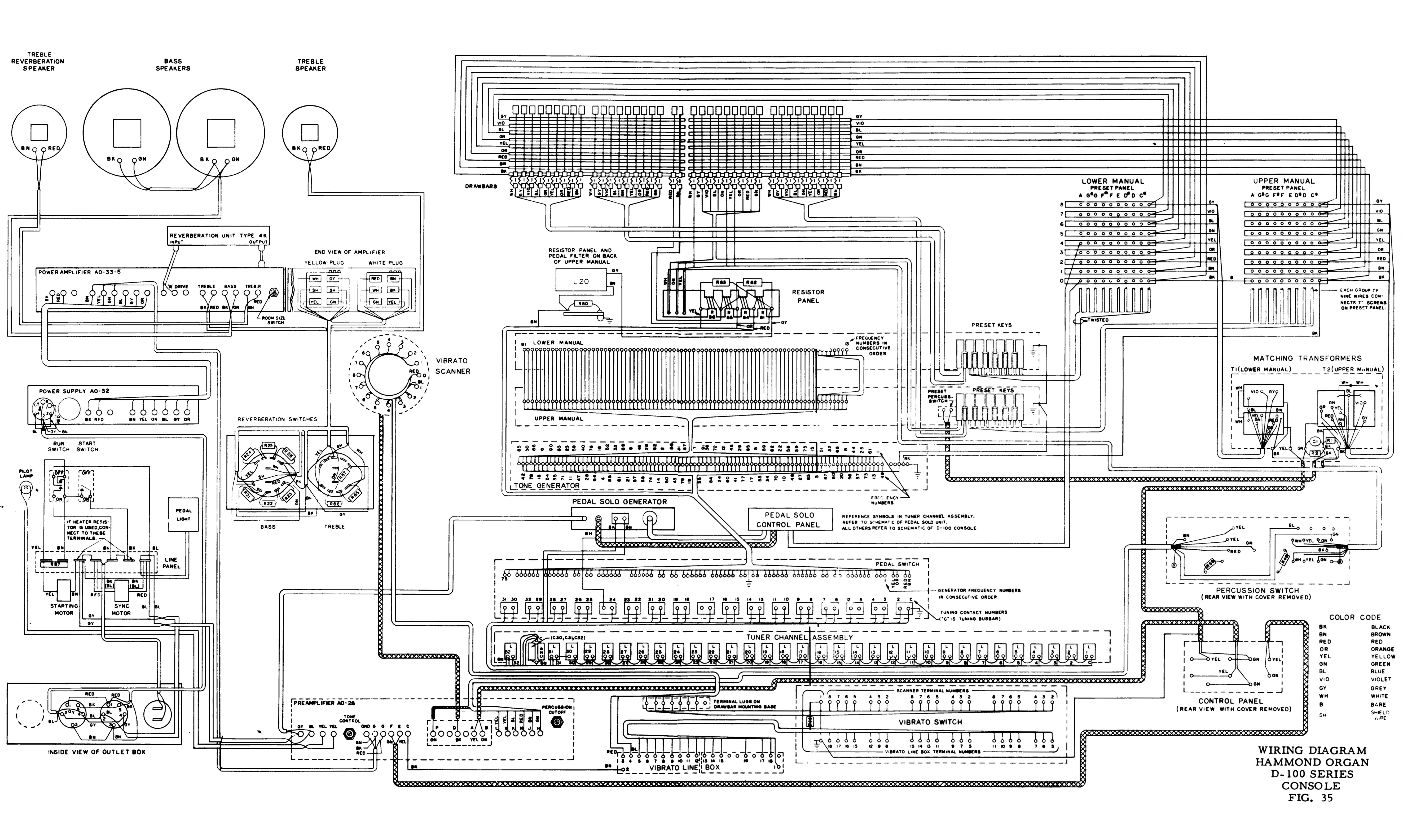
FIGURE 25A-WIRING DIAGRAM OF HAMMOND ORGAN CONSOLE MODEL RT-3

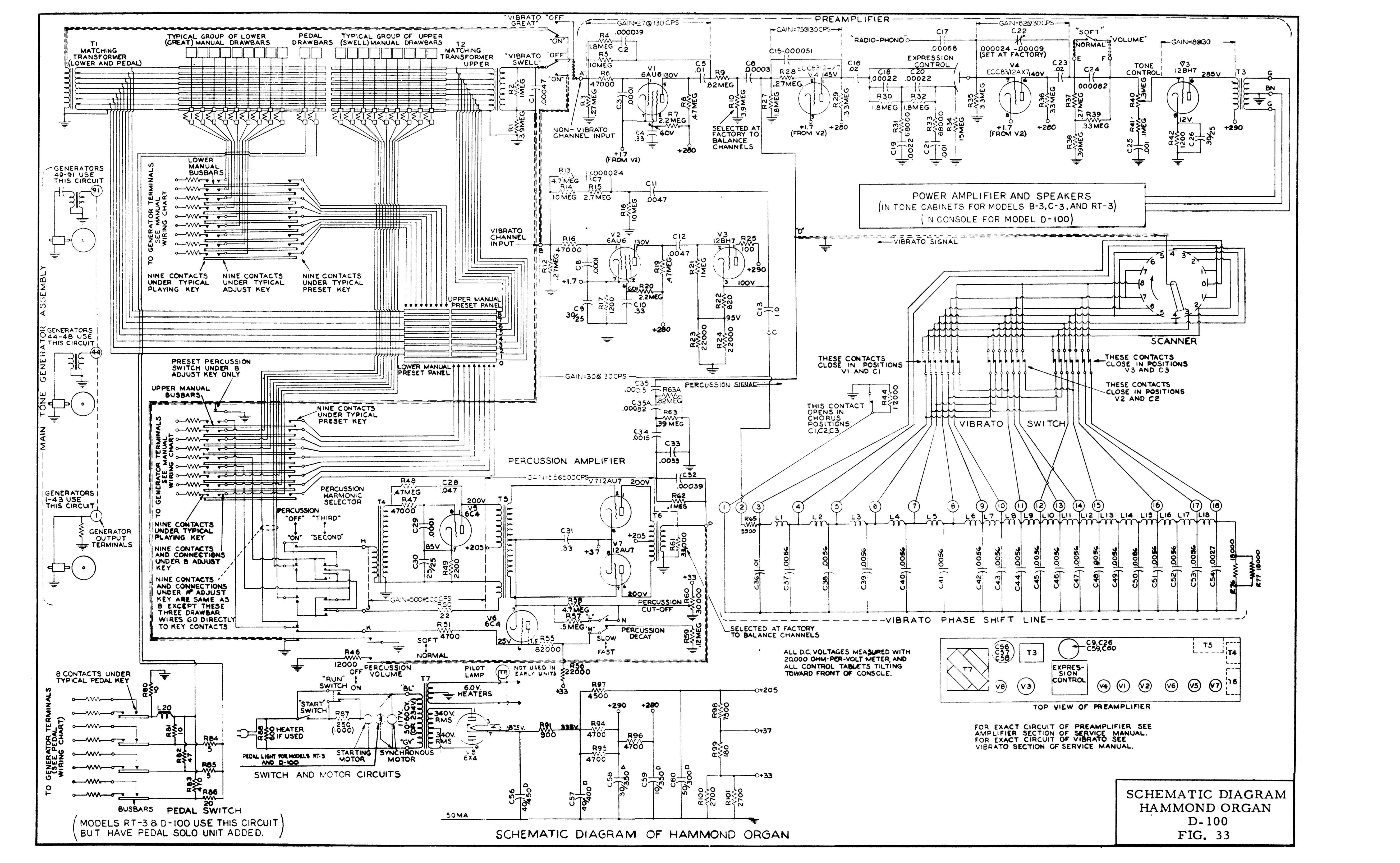


WIRING DIAGRAM
HAMMOND ORGAN
A-100

FIGURE 31


SCHEMATIC DIAGRAM
HAMMOND ORGAN
A-100
A-101
A-102
PREAMPLIFIER
PERCUSSION AMPLIFIER
VIBRATO PHASE SHIFT LINE
SCANNER
VIBRATO SWITCH
VIBRATO SIGNAL
PERCUSSION SIGNAL
REVERBERATION UNIT
AO-39 POWER AMPLIFIER
AO-35 REVERBERATION AMPLIFIER
TO SWELL PEDAL HOUSING
SWITCH & MOTOR CIRCUITS
MAIN TONE GENERATOR ASSEMBLY
T1 MATCHING TRANSFORMER (LOWER AND PEDAL)
T2 MATCHING TRANSFORMER UPPER
TYPICAL GROUP OF LOWER (GREAT) MANUAL DRAWBARS
PEDAL DRAWBARS
TYPICAL GROUP OF UPPER (SWELL) MANUAL DRAWBARS
UPPER MANUAL PRESET PANEL
LOWER MANUAL PRESET PANEL
PEDAL SWITCH
TOP VIEW OF PREAMPLIFIER
ALL D.C. VOLTAGES MEASURED WITH 20000 OHM-PER-VOLT METER AND ALL CONTROL TABLETS TILTING TOWARD FRONT OF CONSOLE


TREBLE REVERBERATION SPEAKER
BASS SPEAKERS
TREBLE SPEAKER
REVERBERATION UNIT TYPE 4K
INPUT
OUTPUT
POWER AMPLIFIER AO-33-5
'R' DRIVE
TREBLE
BASS
TREB.R
ROOM SIZE SWITCH
END VIEW OF AMPLIFIER
YELLOW PLUG
WHITE PLUG
POWER SUPPLY AO-32
RUN SWITCH
START SWITCH
PILOT LAMP
IF HEATER RESISTOR IS USED, CONNECT TO THESE TERMINALS.
PEDAL LIGHT
LINE PANEL
STARTING MOTOR
SYNC MOTOR
INSIDE VIEW OF OUTLET BOX
REVERBERATION SWITCHES
BASS
TREBLE
VIBRATO SCANNER
DRAWBARS
RESISTOR PANEL AND PEDAL FILTER ON BACK OF UPPER MANUAL
RESISTOR PANEL
LOWER MANUAL
PRESET PANEL
UPPER MANUAL
PRESET PANEL
EACH GROUP OF NINE WIRES CONNECTS TO SCREWS ON PRESET PANEL
TWISTED
PRESET KEYS
PRESET PERCUSS. SWITCH
MATCHING TRANSFORMERS
T1 (LOWER MANUAL)
T2 (UPPER MANUAL)
FREQUENCY NUMBERS IN CONSECUTIVE ORDER
LOWER MANUAL
UPPER MANUAL
TONE GENERATOR
FREQUENCY NUMBERS
PEDAL SOLO GENERATOR
PEDAL SOLO CONTROL PANEL
REFERENCE SYMBOLS IN TUNER CHANNEL ASSEMBLY. REFER TO SCHEMATIC OF PEDAL SOLO UNIT.
ALL OTHERS REFER TO SCHEMATIC OF D-100 CONSOLE.
PEDAL SWITCH
GENERATOR FREQUENCY NUMBERS IN CONSECUTIVE ORDER.
TUNING CONTACT NUMBERS ("C" IS TUNING BUSBAR)
TUNER CHANNEL ASSEMBLY
(C30, C31, C32)
PERCUSSION SWITCH
(REAR VIEW WITH COVER REMOVED)
CONTROL PANEL
(REAR VIEW WITH COVER REMOVED)
PREAMPLIFIER AO-28
TONE CONTROL
PERCUSSION CUTOFF
TERMINAL LUGS ON DRAWBAR MOUNTING BASE
SCANNER TERMINAL NUMBERS
VIBRATO SWITCH
VIBRATO LINE BOX TERMINAL NUMBERS
VIBRATO LINE BOX
COLOR CODE
BK BLACK
BN BROWN
RED RED
OR ORANGE
YEL YELLOW
GN GREEN
BL BLUE
VIO VIOLET
GY GREY
WH WHITE
B BARE
SH SHIELD WIRE
WIRING DIAGRAM
HAMMOND ORGAN
D-100 SERIES
CONSOLE
FIG. 35



SCHEMATIC DIAGRAM OF HAMMOND ORGAN

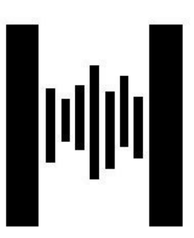
SCHEMATIC DIAGRAM
HAMMOND ORGAN
D-100
FIG. 33

THE HAMMOND ORGAN

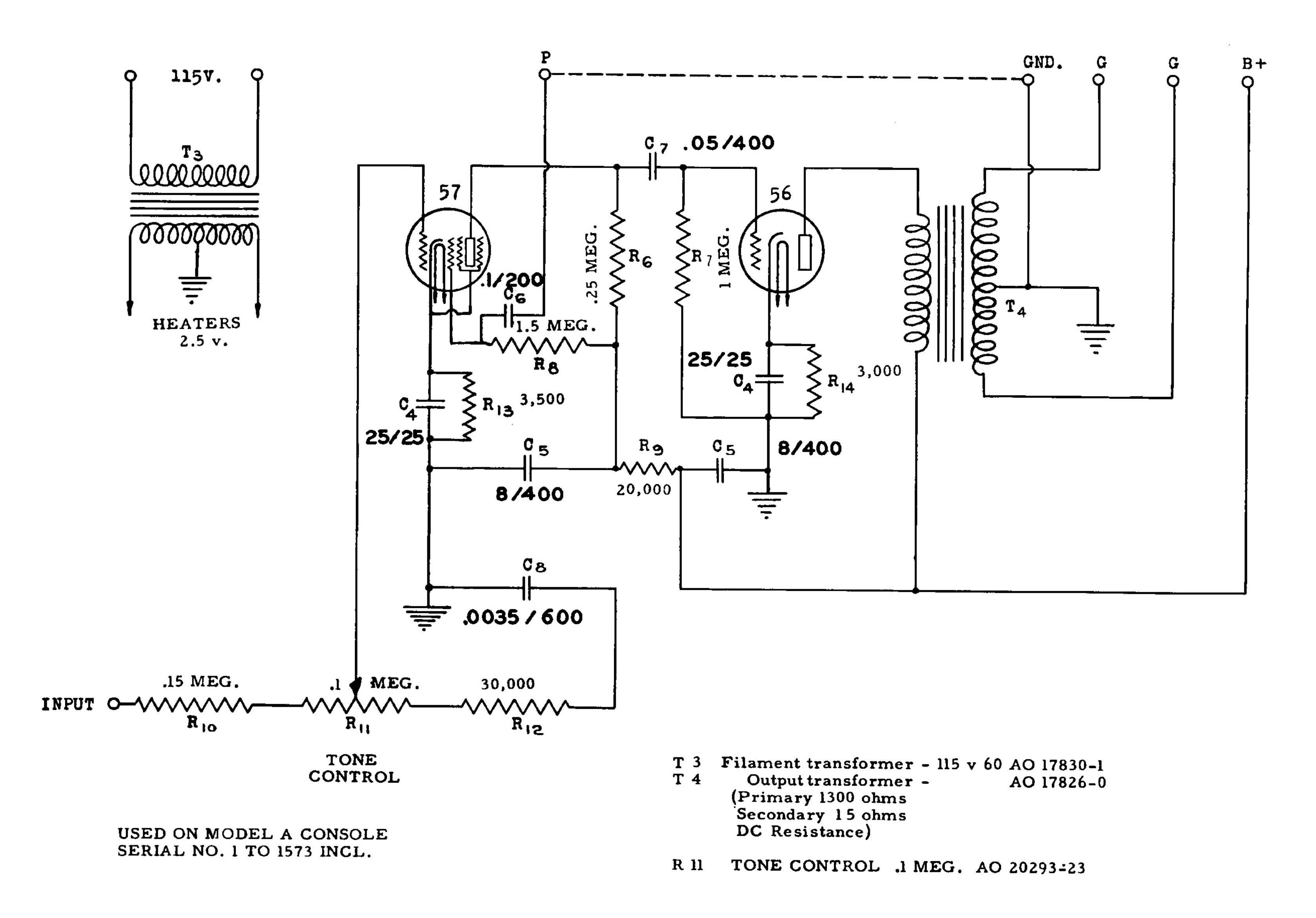
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WIRING & SCHEMATIC DIAGRAMS

PART 2 - CONSOLE PRE-AMPLIFIERS



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA



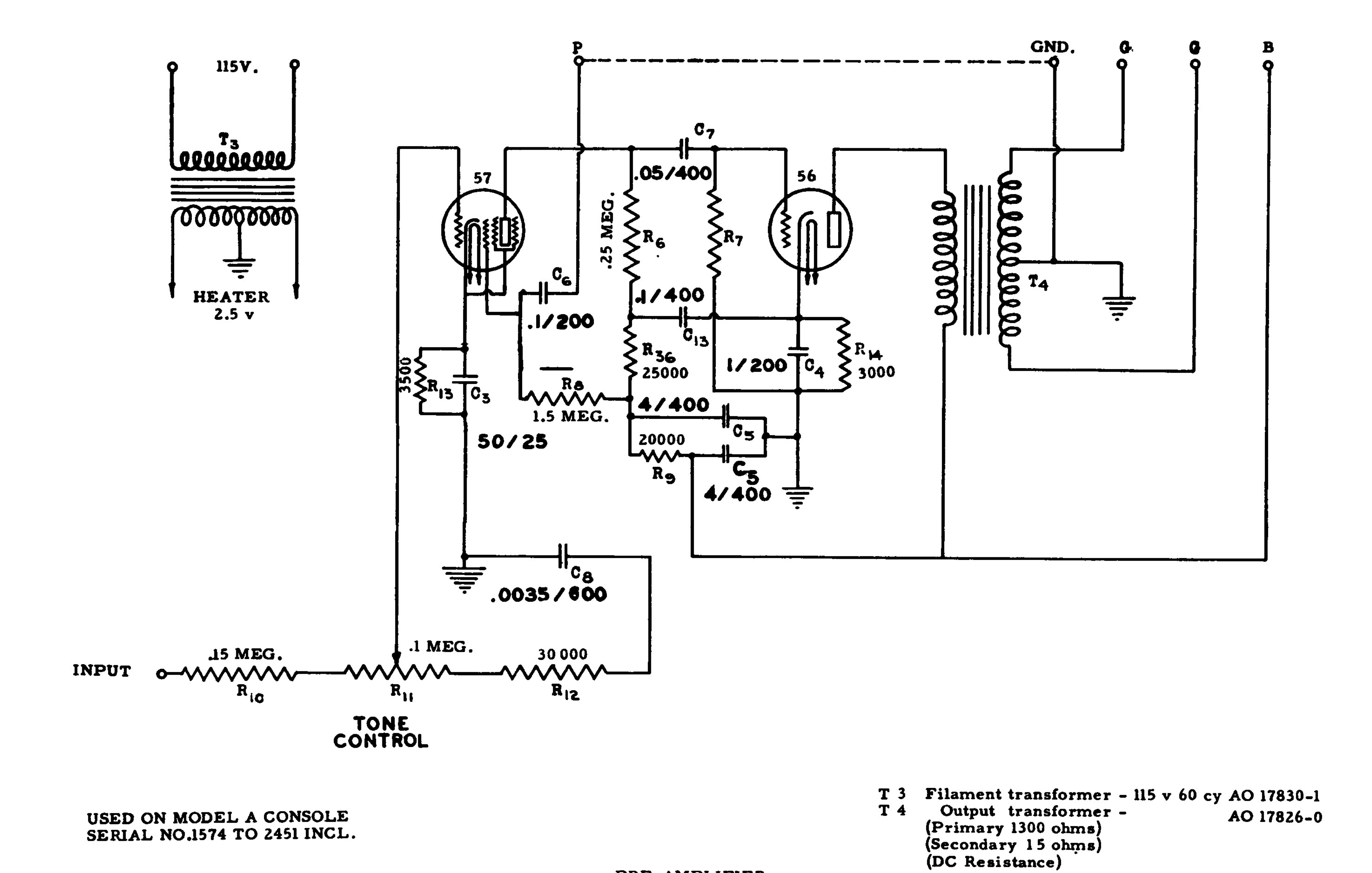
USED ON MODEL A CONSOLE
SERIAL NO. 1 TO 1573 INCL.

T 3 Filament transformer - 115 v 60 AO 17830-1
T 4 Output transformer - AO 17826-0
(Primary 1300 ohms
Secondary 15 ohms
DC Resistance)

R 11 TONE CONTROL .1 MEG. AO 20293-23

PRE-AMPLIFIER

FIGURE 1



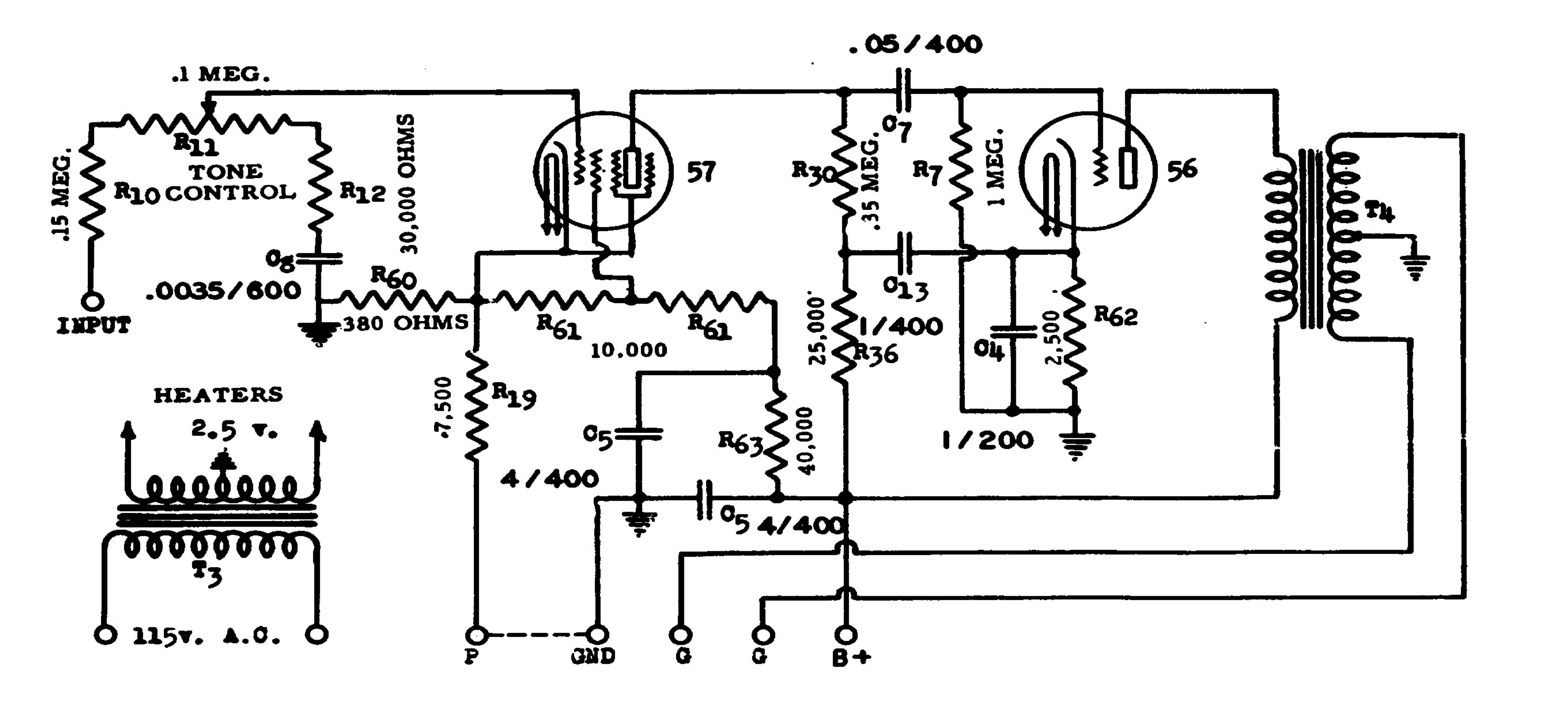
USED ON MODEL A CONSOLE
SERIAL NO.1574 TO 2451 INCL.

USED ON MODEL B CONSOLE
SERIAL NO. 4000 TO 5539 INCL.

-PRE-AMPLIFIER-
FIGURE 2

T 3 Filament transformer - 115 v 60 cy AO 17830-1
T 4 Output transformer - AO 17826-0
(Primary 1300 ohms)
(Secondary 15 ohms)
(DC Resistance)

R11 TONE CONTROL .1 MEG. AO 20293-23



USED ON MODEL A CONSOLE
SERIAL NO. 2452 TO 2559 INCL.

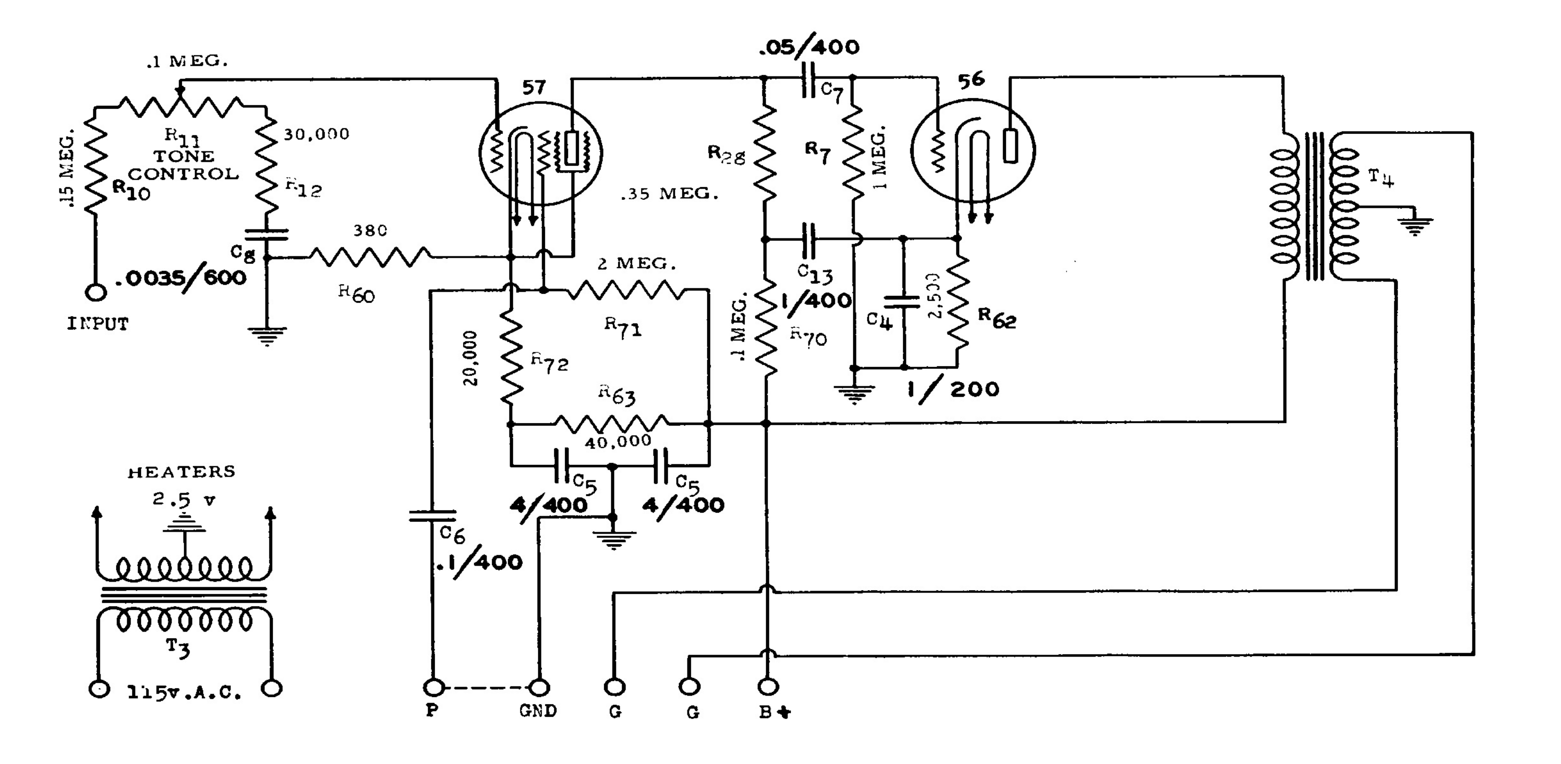
USED ON MODEL B CONSOLE
SERIAL NO. 5540 TO 5939 INCL.

T 3	Filament transformer	115 v 60 cy	AO 17830-1
T 4	Output transformer (Primary 1300 ohms, Secondary 15 ohms DC Resistance)		AO 17826-0

R 11 TONE CONTROL .1 MEG. AO 20293-23

PRE-AMPLIFIER

FIGURE 3

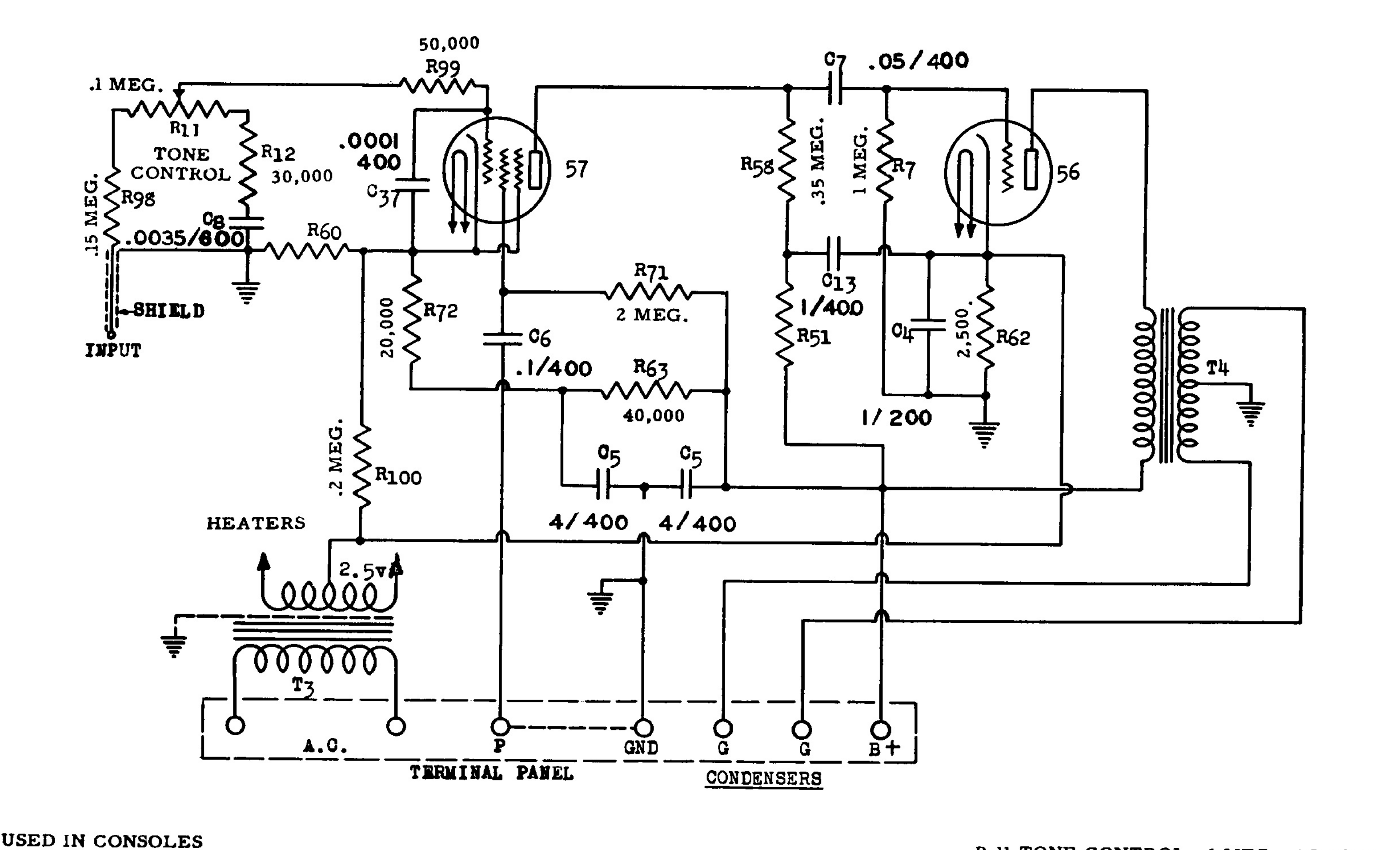


USED IN CONSOLES
MODEL A SERIAL NO. 2560 TO 2646 INCL.
MODEL B SERIAL NO. 5940 TO 10032 INCL.
MODEL C SERIAL NO. 1203 TO 1212 INCL.
MODEL D SERIAL NO. 1 TO 1208 INCL.
PLAYER SERIAL NO. 9000 TO 9123 INCL.

T 3 Filament transformer 115 v 60 cy AO 17830-1
T 4 Output transformer AO 17826-1
(Primary 1300 ohms, Secondary 15 ohms DC Resistance)

R 11 TONE CONTROL .1 MEG. · AO 20293-23

PRE-AMPLIFIER
FIGURE 4



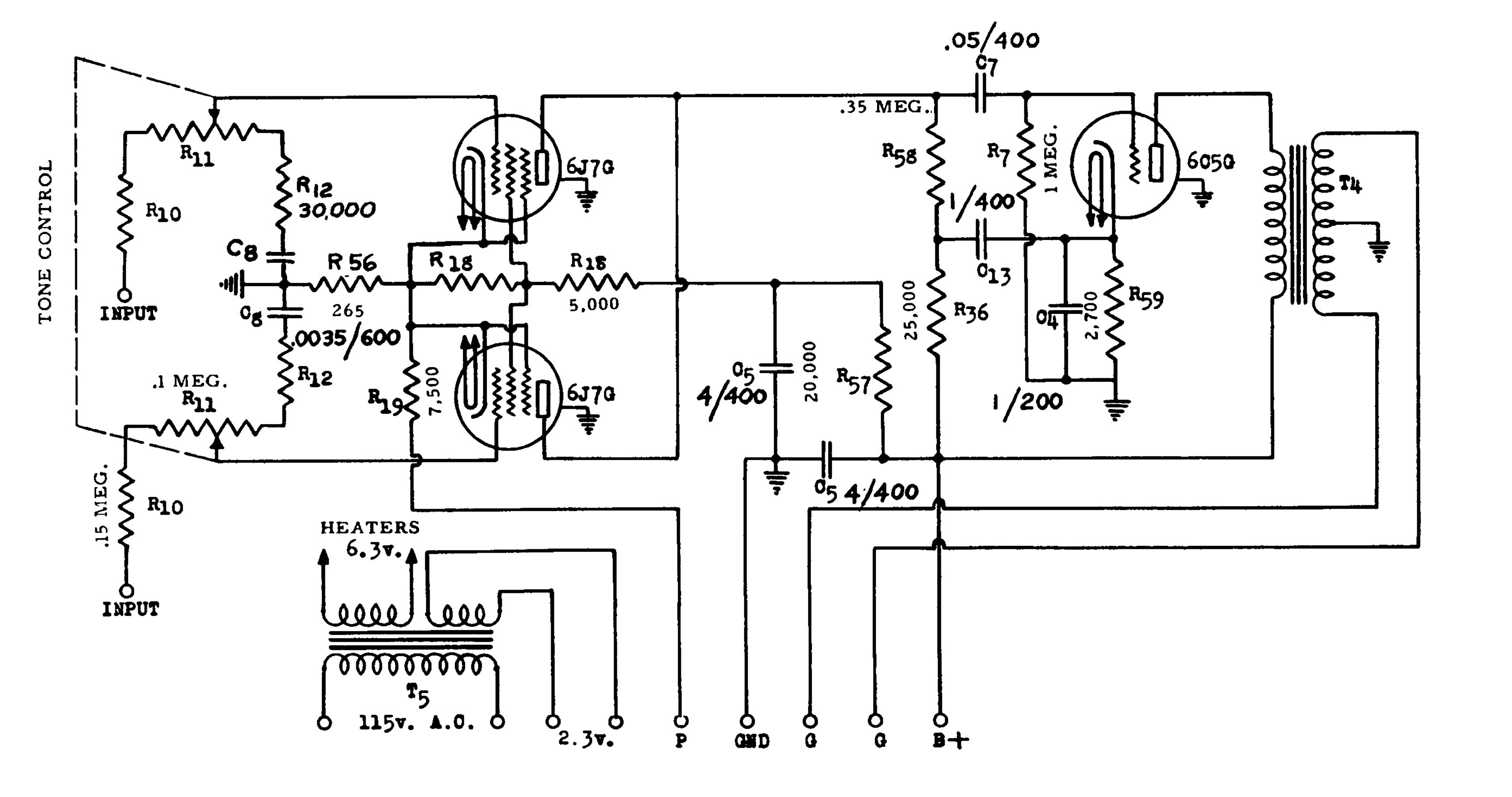
USED IN CONSOLES
MODEL A SERIAL NO. 2647 TO 2711 INCL.
MODEL B SERIAL NO. 10033 TO 11205 INCL.
MODEL C SERIAL NO. 1213 TO 1298 INCL.
MODEL D SERIAL NO. 1809 TO 9268 INCL.
PLAYER SERIAL NO. 9124 & 9210
MODEL G - ALL

R 11 TONE CONTROL .1 MEG. AO 20293-23

T 3 Filament transformer 115 v 60 cy AO 17830-1
T 4 Output transformer AO 17826-1

PRE-AMPLIFIER

FIGURE 5



USED IN MODEL E CONSOLE
SERIAL NO. 8000 TO 8472 INCL.

T 4 Filament transformer		AO 17826-0
T 5 Output transformer		AO 17831-1
R 11 DUAL CONTROL	.1 MEG.	AO 16533-0

PRE AMPLIFIER

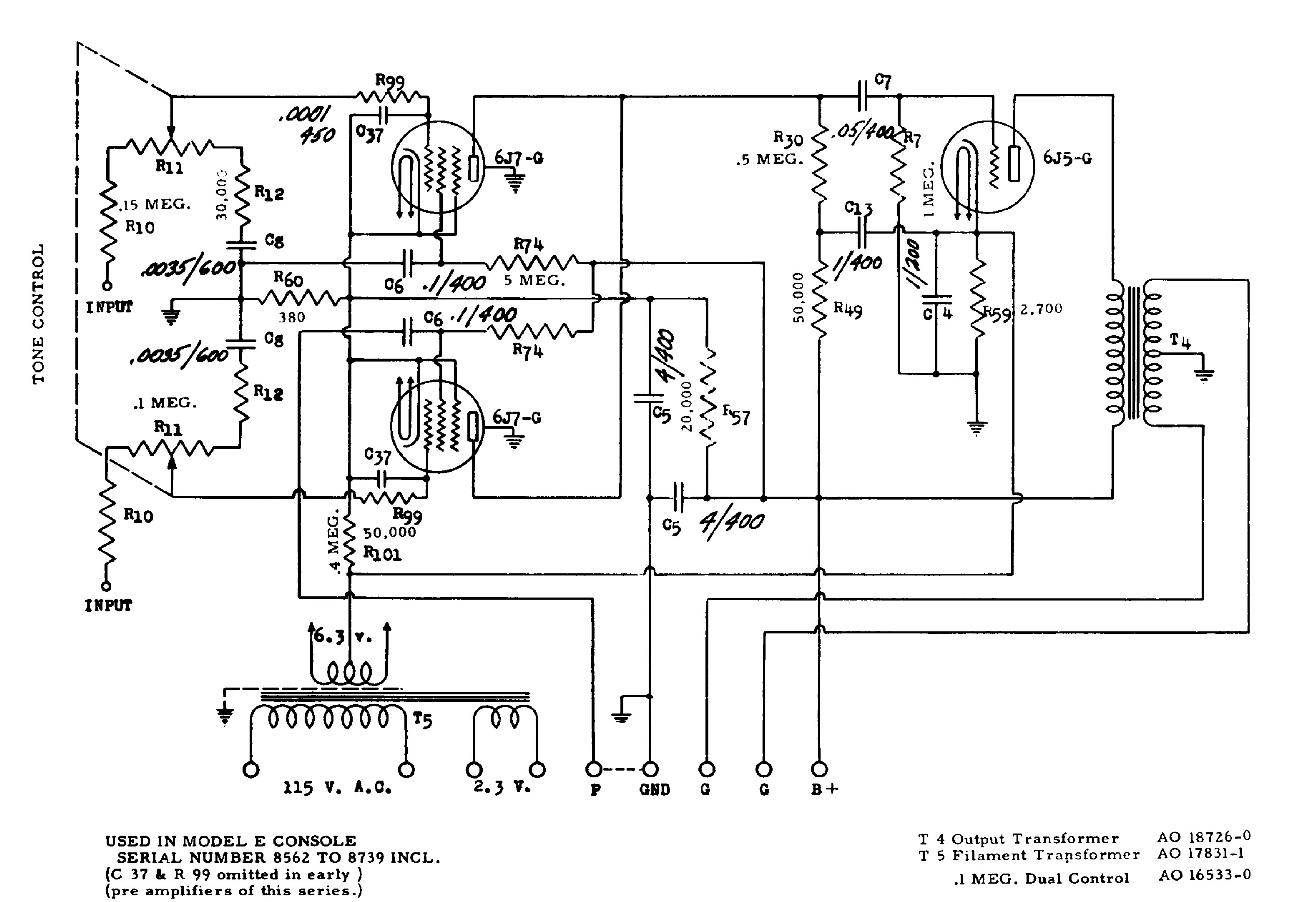
FIGURE 7

USED IN MODEL E CONSOLE
SERIAL NUMBER 8473 TO 8561 INCL.

T 4 Output Transformer AO 17826-0
T 5 Filament Transformer AO 17831-1
R 11 Dual Control .1 MEG. AO 16533-0

PRE AMPLIFIER

FIGURE 8



USED IN MODEL E CONSOLE
SERIAL NUMBER 8562 TO 8739 INCL.
(C 37 & R 99 omitted in early)
(pre amplifiers of this series.)

T 4	Output Transformer	AO 18726-0
T 5	Filament Transformer	AO 17831-1
	.1 MEG. Dual Control	AO 16533-0

PRE AMPLIFIER

FIGURE 9

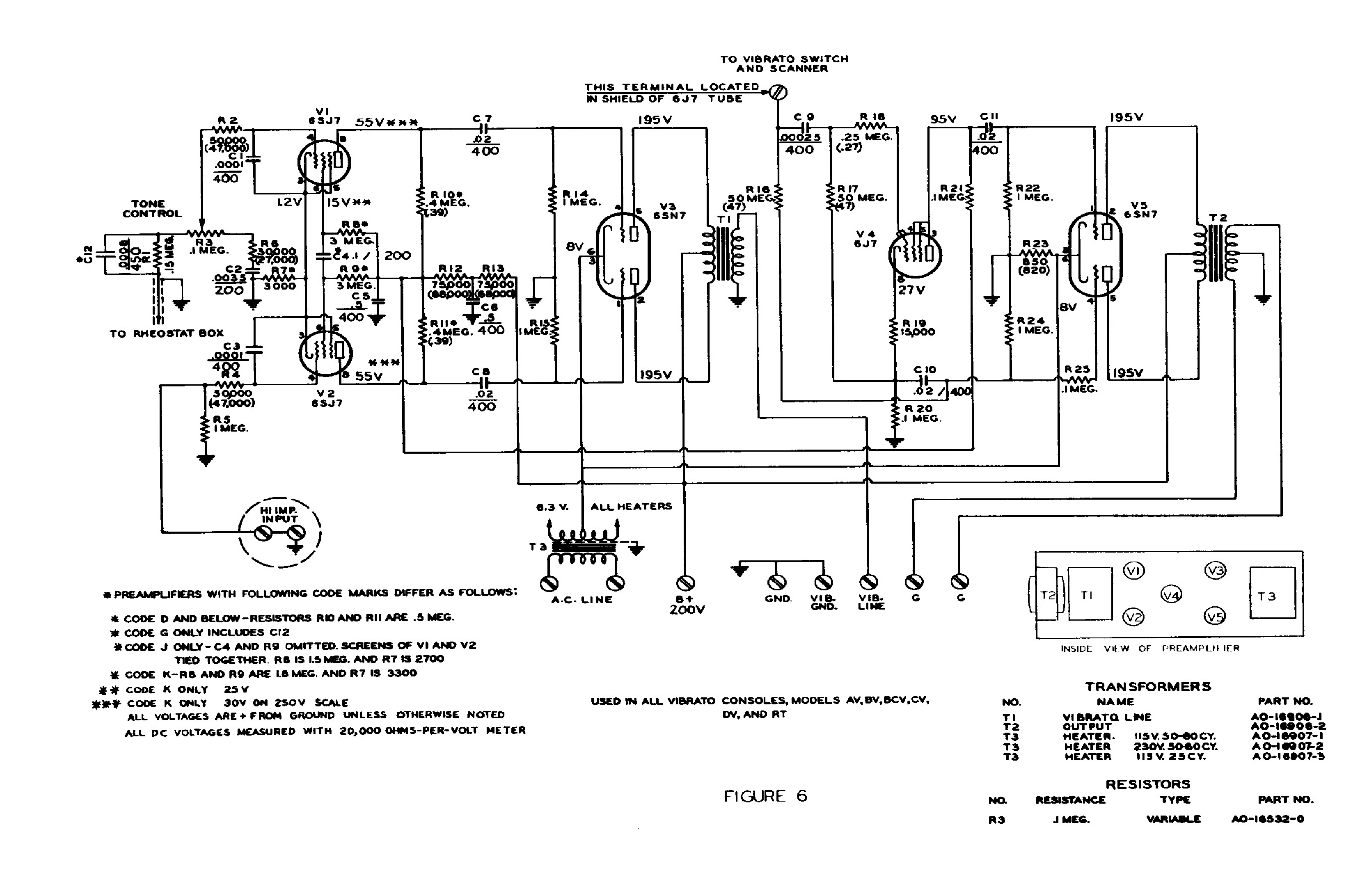
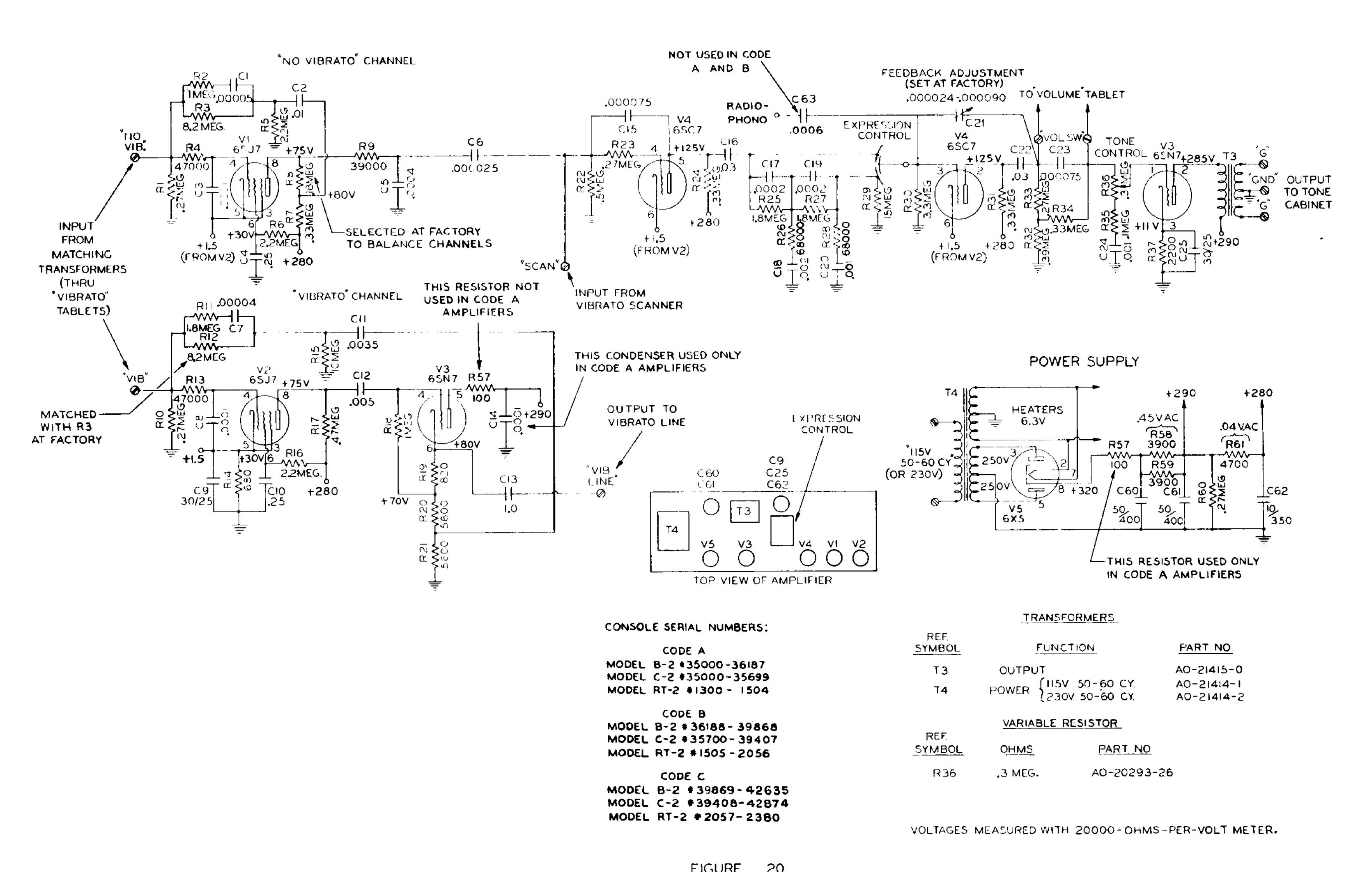

TO VIBRATO SWITCH AND SCANNER
THIS TERMINAL LOCATED IN SHIELD OF 6J7 TUBE
TONE CONTROL
TO RHEOSTAT BOX
V1 6SJ7
V2 6SJ7
V3 6SN7
V4 6J7
V5 6SN7
T1
T2
T3
55V***
15V**
12V
55V
195V
95V
27V
8V
6.3 V.
ALL HEATERS
A.C. LINE
B+ 200V
GND.
VIB. GND.
VIB. LINE
G
G
HI IMP. INPUT
INSIDE VIEW OF PREAMPLIFIER
* PREAMPLIFIERS WITH FOLLOWING CODE MARKS DIFFER AS FOLLOWS:
* CODE D AND BELOW-RESISTORS R10 AND R11 ARE .5 MEG.
* CODE G ONLY INCLUDES C12
* CODE J ONLY-C4 AND R9 OMITTED. SCREENS OF V1 AND V2 TIED TOGETHER. R8 IS 1.5 MEG. AND R7 IS 2700
* CODE K-R8 AND R9 ARE 1.8 MEG. AND R7 IS 3300
** CODE K ONLY 25 V
*** CODE K ONLY 30V ON 250V SCALE
ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED
ALL DC VOLTAGES MEASURED WITH 20,000 OHMS-PER-VOLT METER
USED IN ALL VIBRATO CONSOLES, MODELS AV, BV, BCV, CV, DV, AND RT
TRANSFORMERS
NO. NAME PART NO.
T1 VIBRATO LINE AO-16906-1
T2 OUTPUT AO-16906-2
T3 HEATER. 115V. 50-60CY. AO-16907-1
T3 HEATER 230V. 50-60CY. AO-16907-2
T3 HEATER 115V. 25CY. AO-16907-3
RESISTORS
NO. RESISTANCE TYPE PART NO.
R3 .1 MEG. VARIABLE AO-16532-0

FIGURE 6



CONSOLE SERIAL NUMBERS:

CODE A
MODEL B-2 #35000-36187
MODEL C-2 #35000-35699
MODEL RT-2 #1300 - 1504

CODE B
MODEL B-2 #36188-39868
MODEL C-2 #35700-39407
MODEL RT-2 #1505-2056

CODE C
MODEL B-2 #39869-42635
MODEL C-2 #39408-42874
MODEL RT-2 #2057-2380

TRANSFORMERS

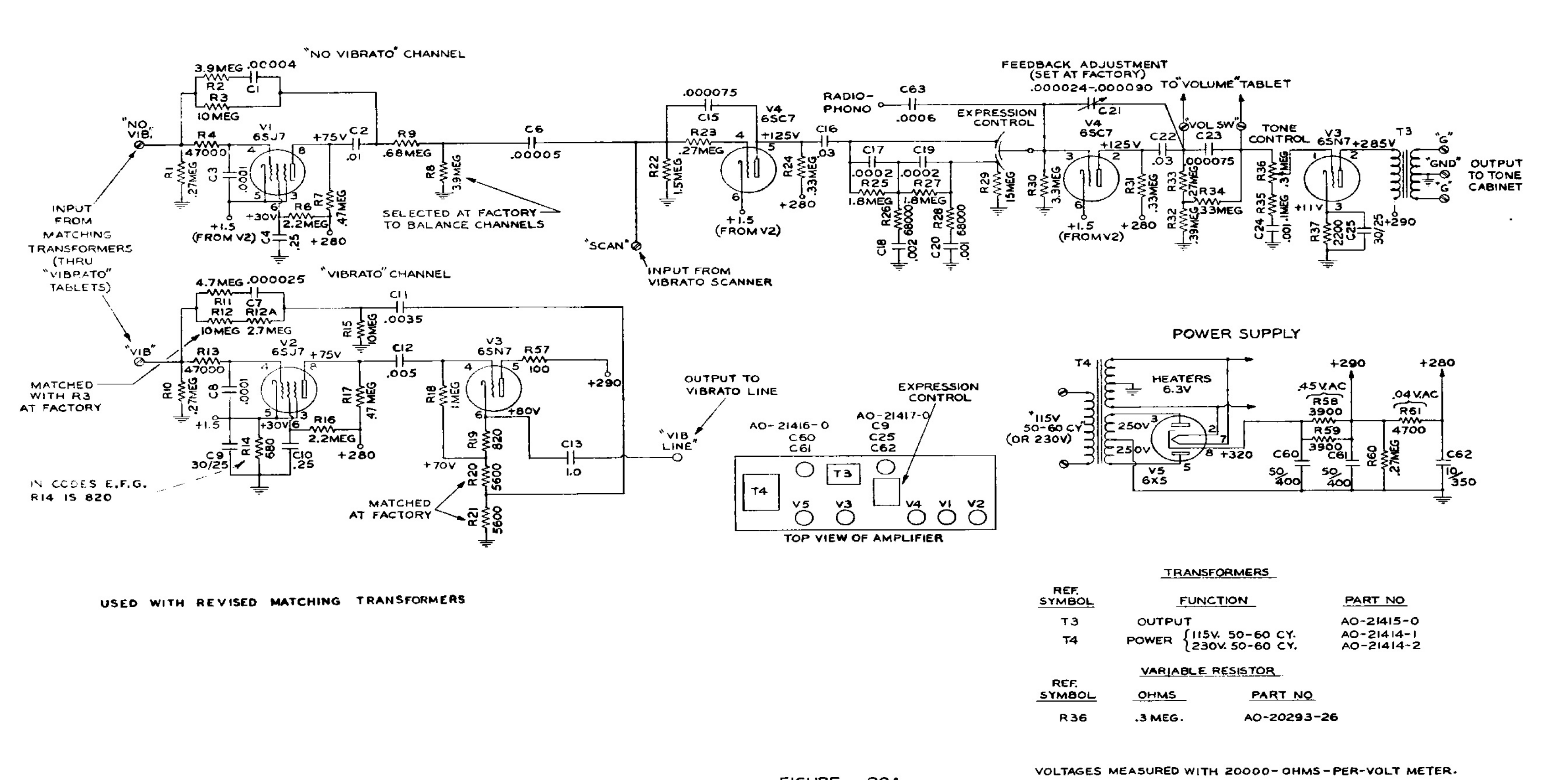
REF. SYMBOL	FUNCTION	PART NO
T3	OUTPUT	AO-21415-0
T4	POWER { 115V. 50-60 CY.	AO-21414-1
	230V. 50-60 CY.	AO-21414-2

VARIABLE RESISTOR

REF. SYMBOL	OHMS	PART NO
R36	.3 MEG.	AO-20293-26

VOLTAGES MEASURED WITH 20000-OHMS-PER-VOLT METER.

FIGURE 20
PREAMPLIFIER - MODELS B2,C2,RT-2
(PREAMPLIFIER TYPE AO-10)
CODE A,B,C



TRANSFORMERS

REF. SYMBOL	FUNCTION	PART NO
T3	OUTPUT	AO-21415-0
T4	POWER {115V. 50-60 CY.	AO-21414-1
	{230V. 50-60 CY.	AO-21414-2

VARIABLE RESISTOR

REF. SYMBOL	OHMS	PART NO
R36	.3 MEG.	AO-20293-26

VOLTAGES MEASURED WITH 20000-OHMS-PER-VOLT METER.

FIGURE 20A
PREAMPLIFIER - MODELS B2, C2, RT-2
(PREAMPLIFIER TYPE AO-10)
CODE D,E,F,G

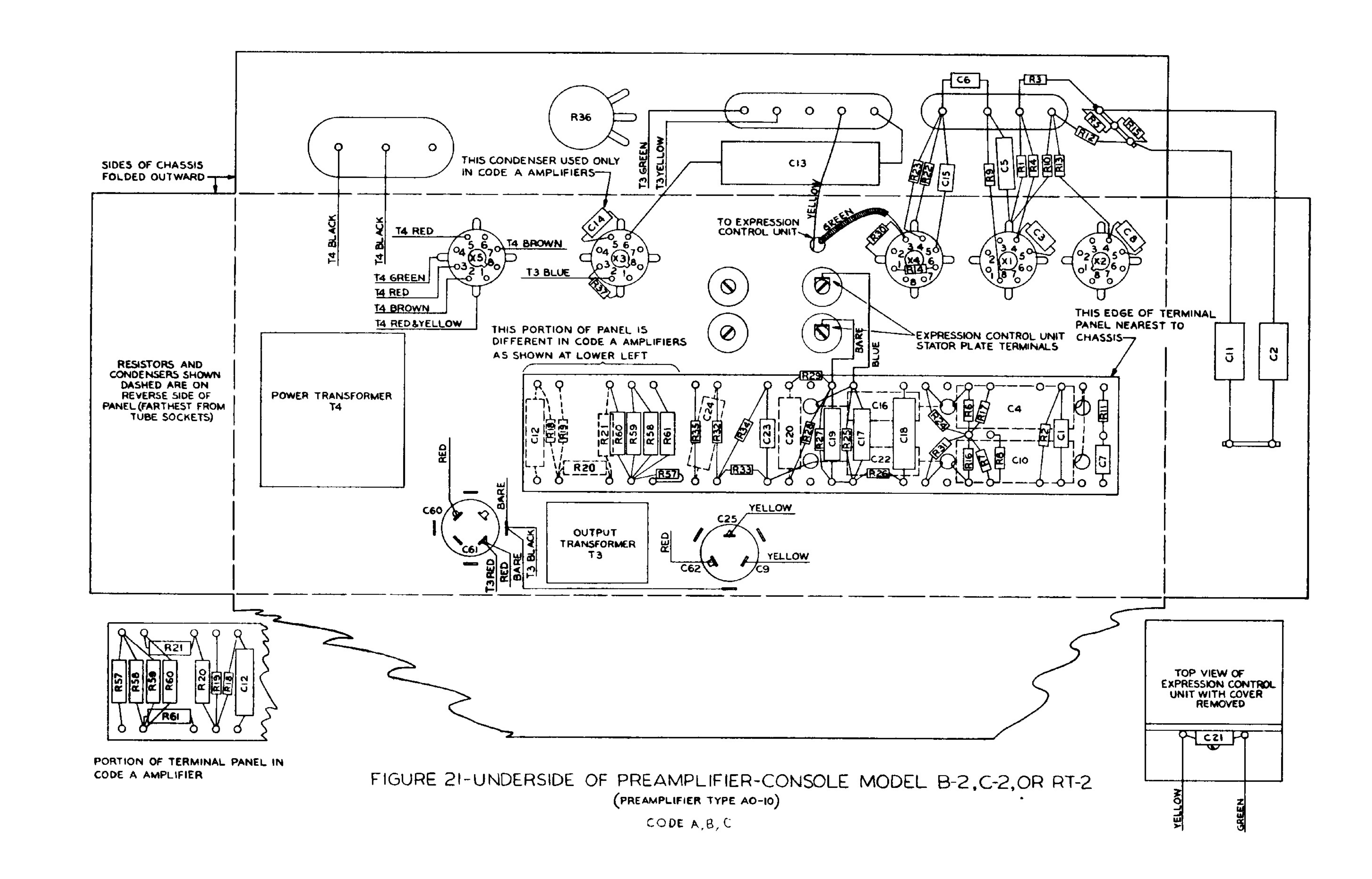


FIGURE 21-UNDERSIDE OF PREAMPLIFIER-CONSOLE MODEL B-2, C-2, OR RT-2
(PREAMPLIFIER TYPE AO-10)
CODE A, B, C

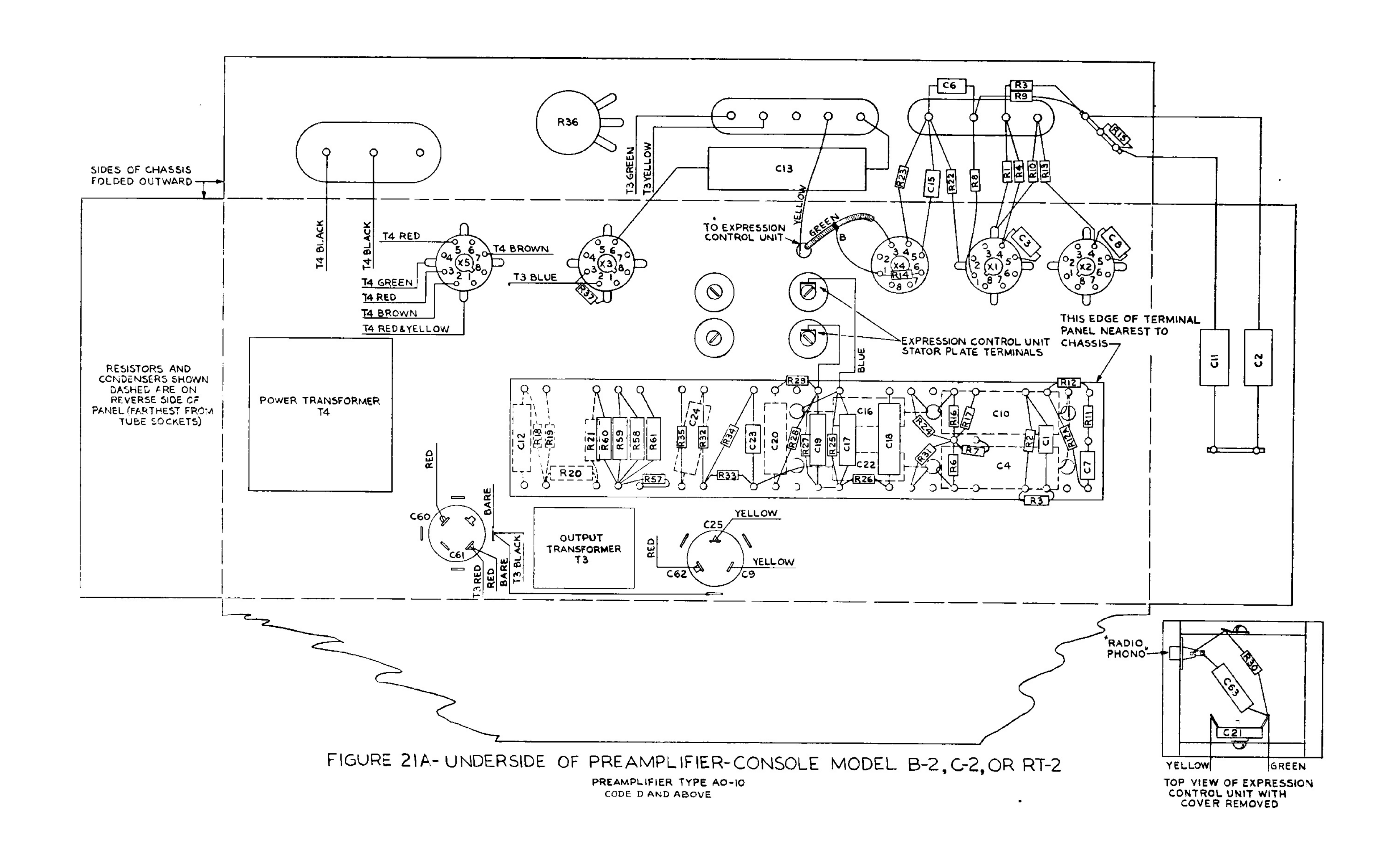


FIGURE 21A- UNDERSIDE OF PREAMPLIFIER-CONSOLE MODEL B-2, C-2, OR RT-2

PREAMPLIFIER TYPE AO-10
CODE D AND ABOVE

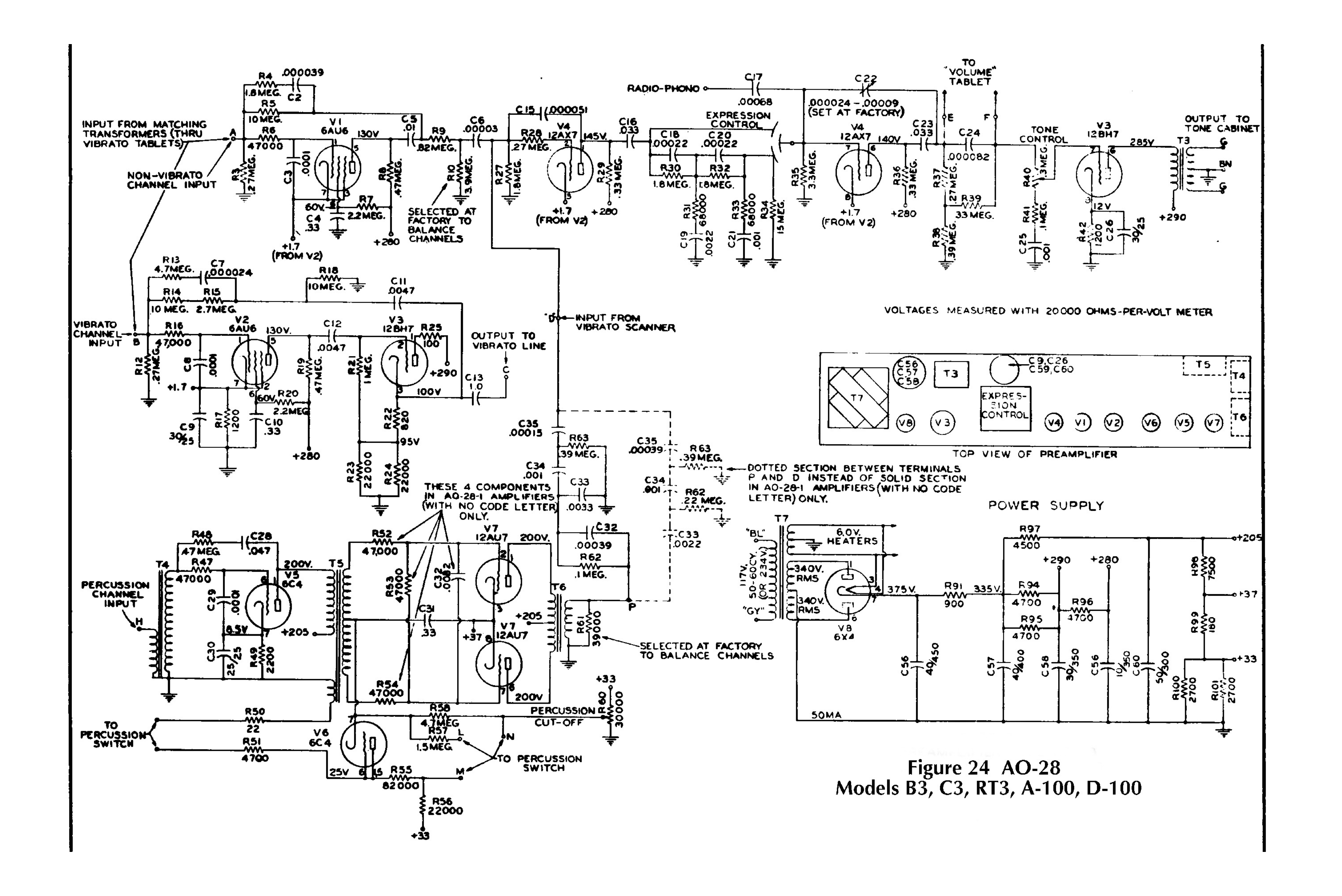


Figure 24 AO-28
Models B3, C3, RT3, A-100, D-100

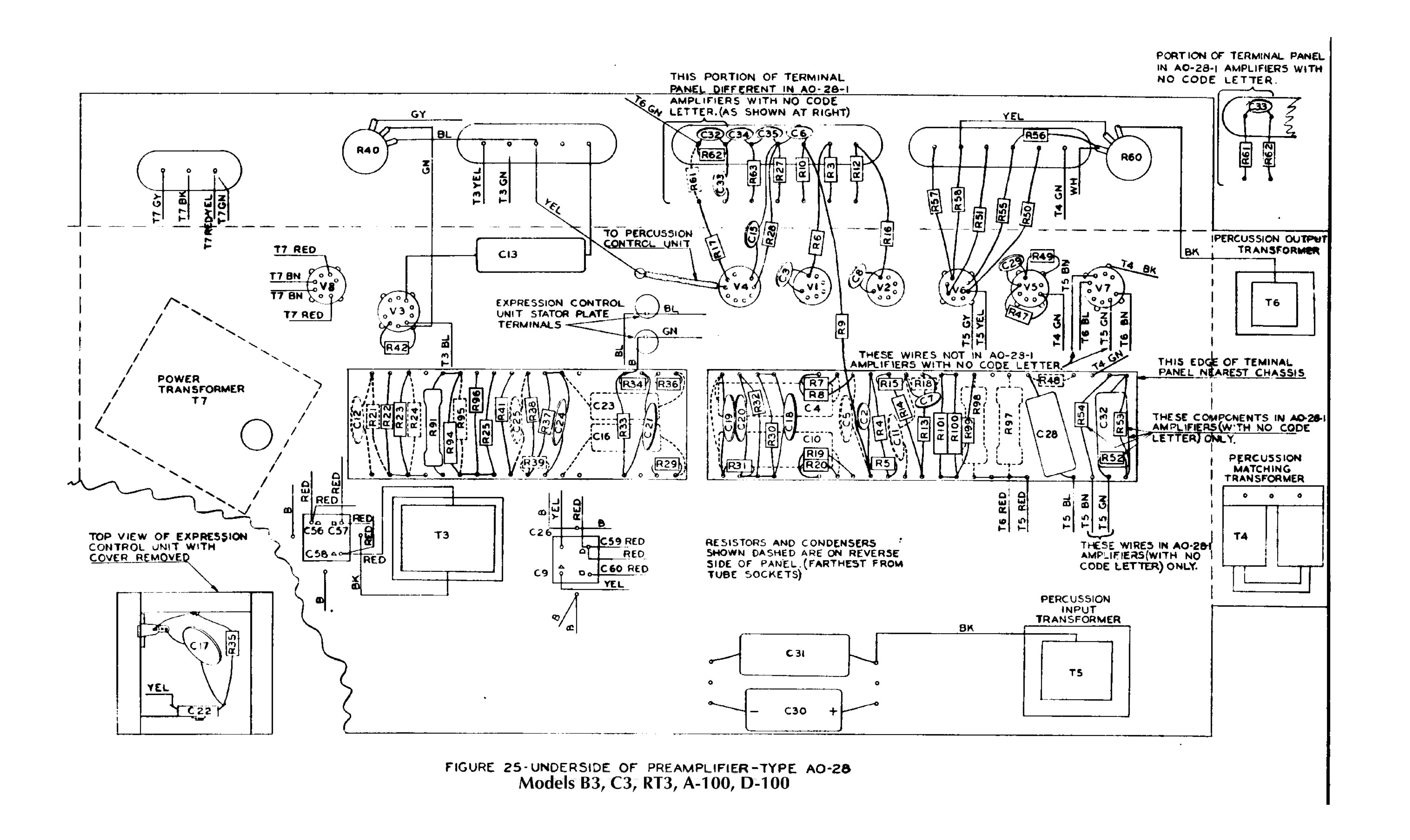


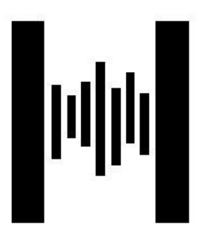
FIGURE 25-UNDERSIDE OF PREAMPLIFIER-TYPE AO-28
Models B3, C3, RT3, A-100, D-100

THE HAMMOND ORGAN

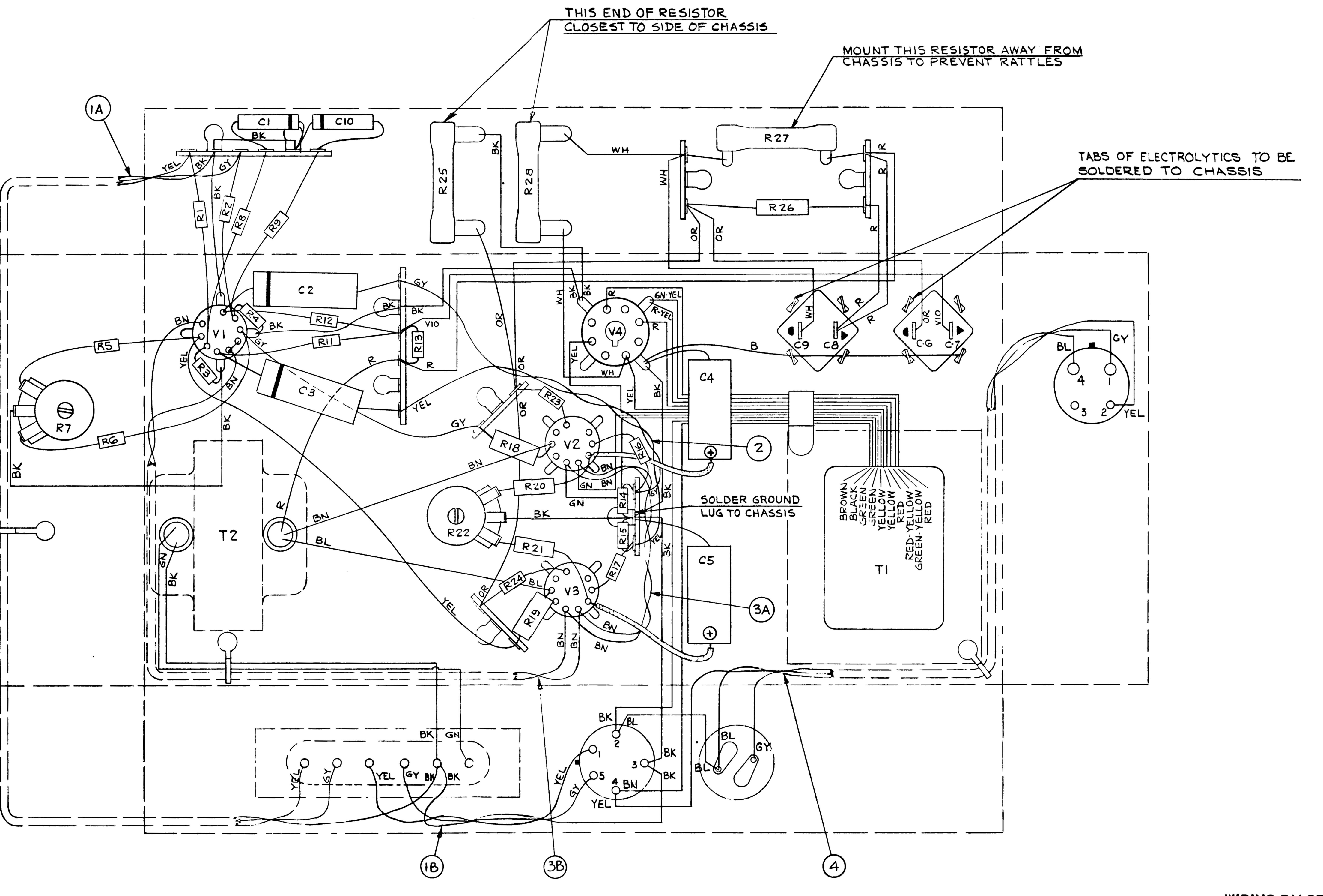
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WIRING & SCHEMATIC
DIAGRAMS

PART 3 - POWER & REVERBERATION AMPLIFIERS IN CONSOLES



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA



WIRING DIAGRAM
AO-39 POWER AMPLIFIER
USED IN HAMMOND ORGAN
A-100

Notes on A0-39 amplifier.

A screwdriver slot on the top marked "hum balance" is used to balance the output tubes for minimum hum. It will probably not have to be changed unless the 6BQ5 tubes are replaced or reversed. To adjust it, ground both "signal input" terminals of the amplifier and set the control for minimum hum at the "speaker" terminals.

A screwdriver slot marked "signal balance" on the side of the amplifier is a factory adjustment to balance the output tube signals for minimum distortion. It should not need to be changed, and should never be used to compensate for unsatisfactory tubes. If there appears to be a serious unbalance, first try replacing tubes. If it is concluded that this control needs to be adjusted, feed a 400 cycle push-pull signal (6-8 volts) into the "signal input" terminals and adjust the control to give equal signal voltages at the plates of the two 6BQ5 tubes.

NOTES:

1. ALL RESISTORS 0.5 W. 10% WHEN NOT STATED OTHERWISE.
2. ALL D.C. VOLTAGES MEASURED WITH A VTVM AT A LINE VOLTAGE OF 117 V. A.C.
3. ☐ 1 KC SIGNAL VOLTAGES, MEASURED WITH AN AUDIO VTVM FROM POINT INDICATED TO CHASSIS

SCHEMATIC DIAGRAM
AO-39 POWER AMP
for
A-100 ORGAN

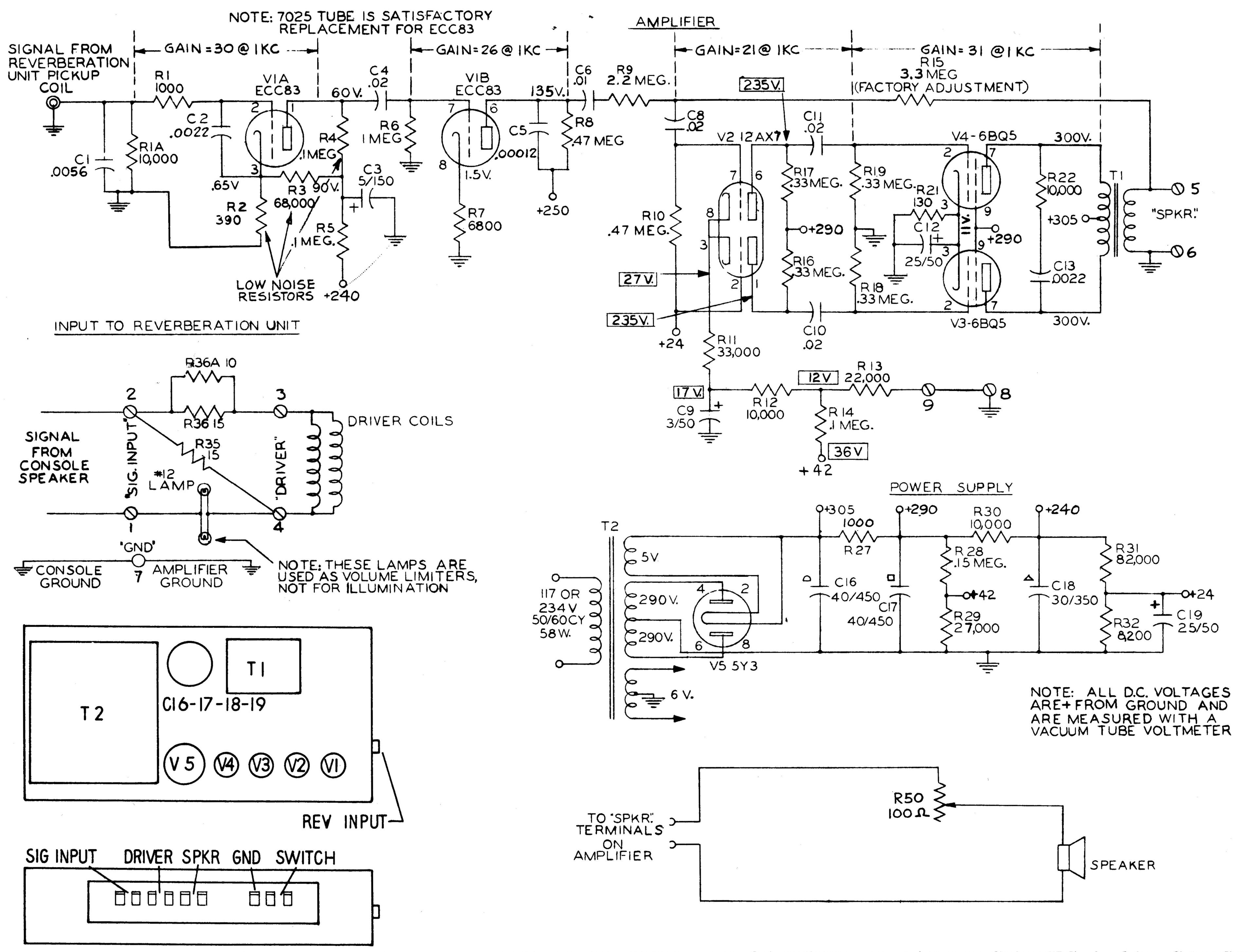


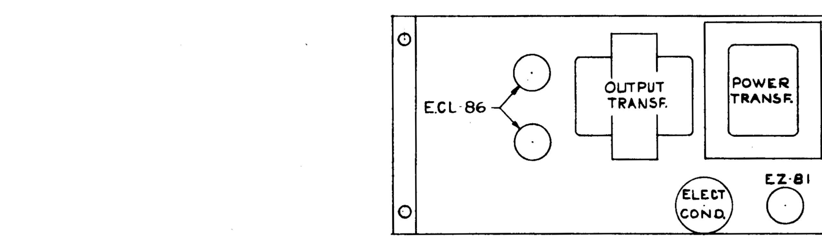
FIGURE 34 - SCHEMATIC, REVERBERATION AMPLIFIER AO 35 USED IN EARLY SERIES A-100 CONSOLES

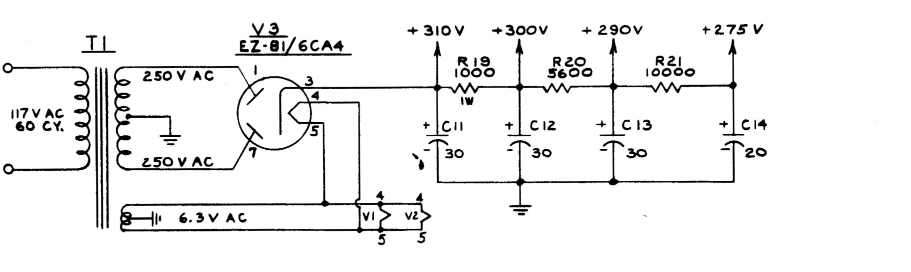
NOTES:

ALL AC VOLTAGES MEASURED WITH A VTVM. (INPUT IMPEDANCE 1 MEG. OHM OR HIGHER)

ALL DC VOLTAGES MEASURED WITH A 20,000 OHMS/VOLT METER

ALL RESISTORS ½W AND 10% UNLESS OTHERWISE SPECIFIED.





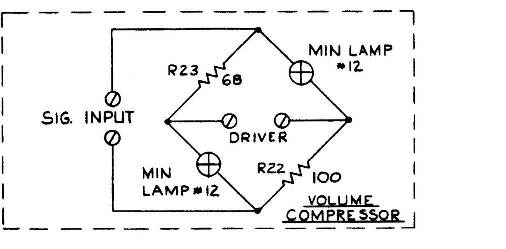
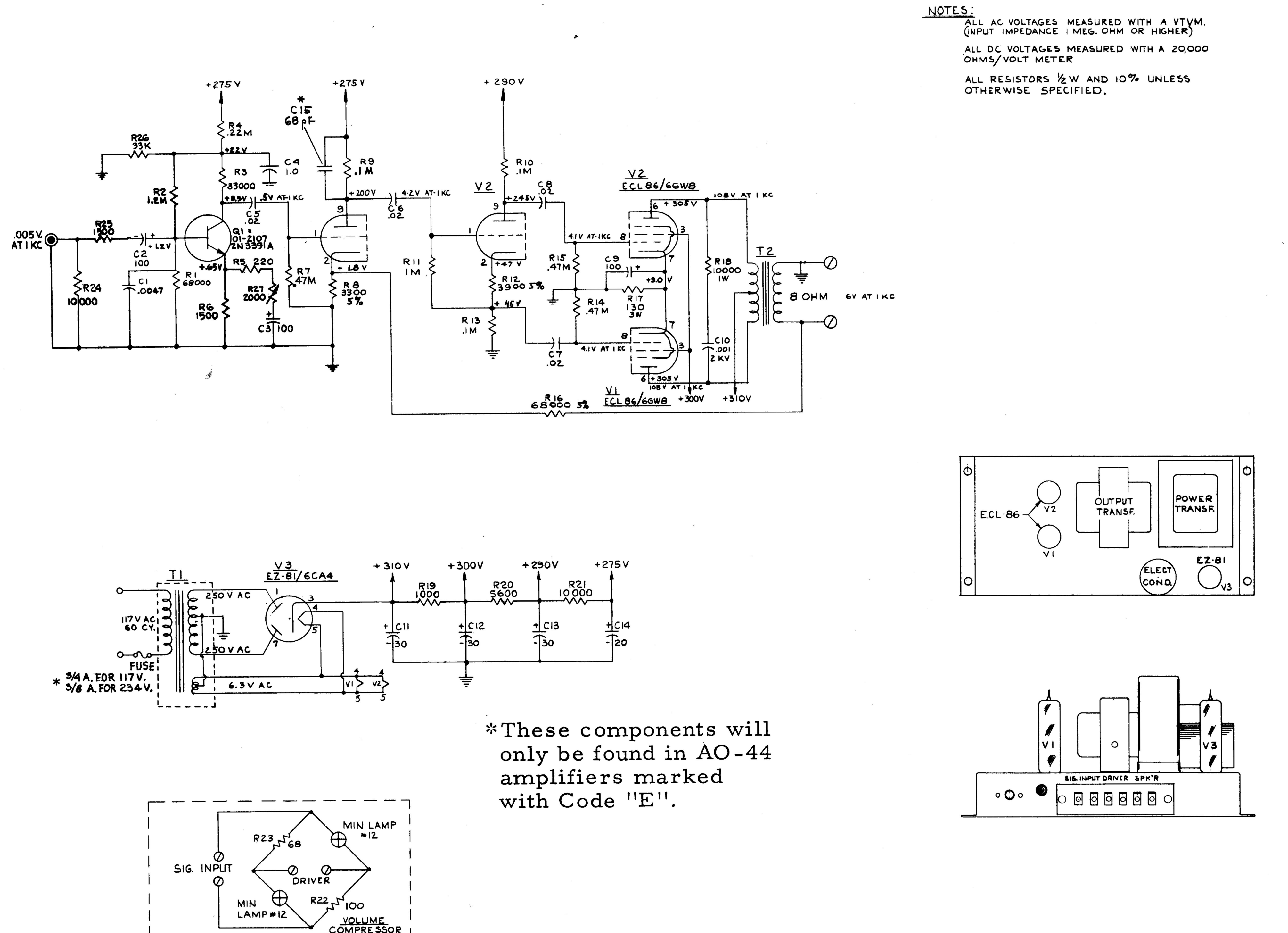



FIGURE 35 - SCHEMATIC, REVERBERATION AMPLIFIER AO-44 USED IN A-100 CONSOLES



*These components will only be found in AO-44 amplifiers marked with Code "E".

FIGURE 35A-SCHEMATIC REVERBERATION AMPLIFIER AO-44 USED IN LATER SERIES A-100 CONSOLES

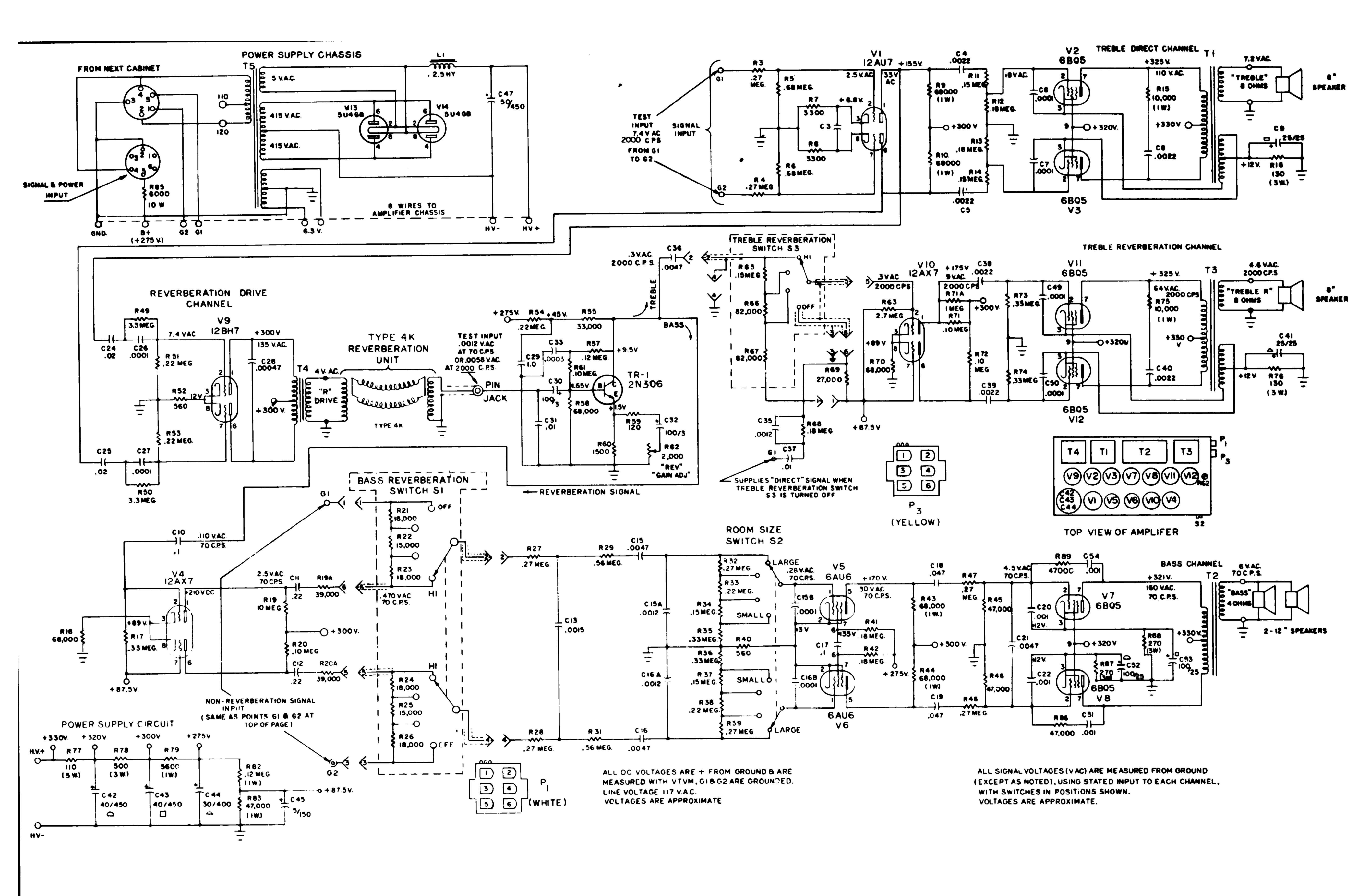


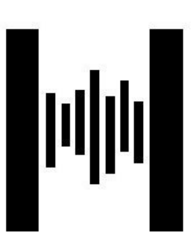
FIGURE 36—AMPLIFIER USED IN D-100 SERIES CONSOLE—A0-33-5

THE HAMMOND ORGAN

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WIRING & SCHEMATIC
DIAGRAMS

PART 4 - PEDAL SOLO UNITS



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

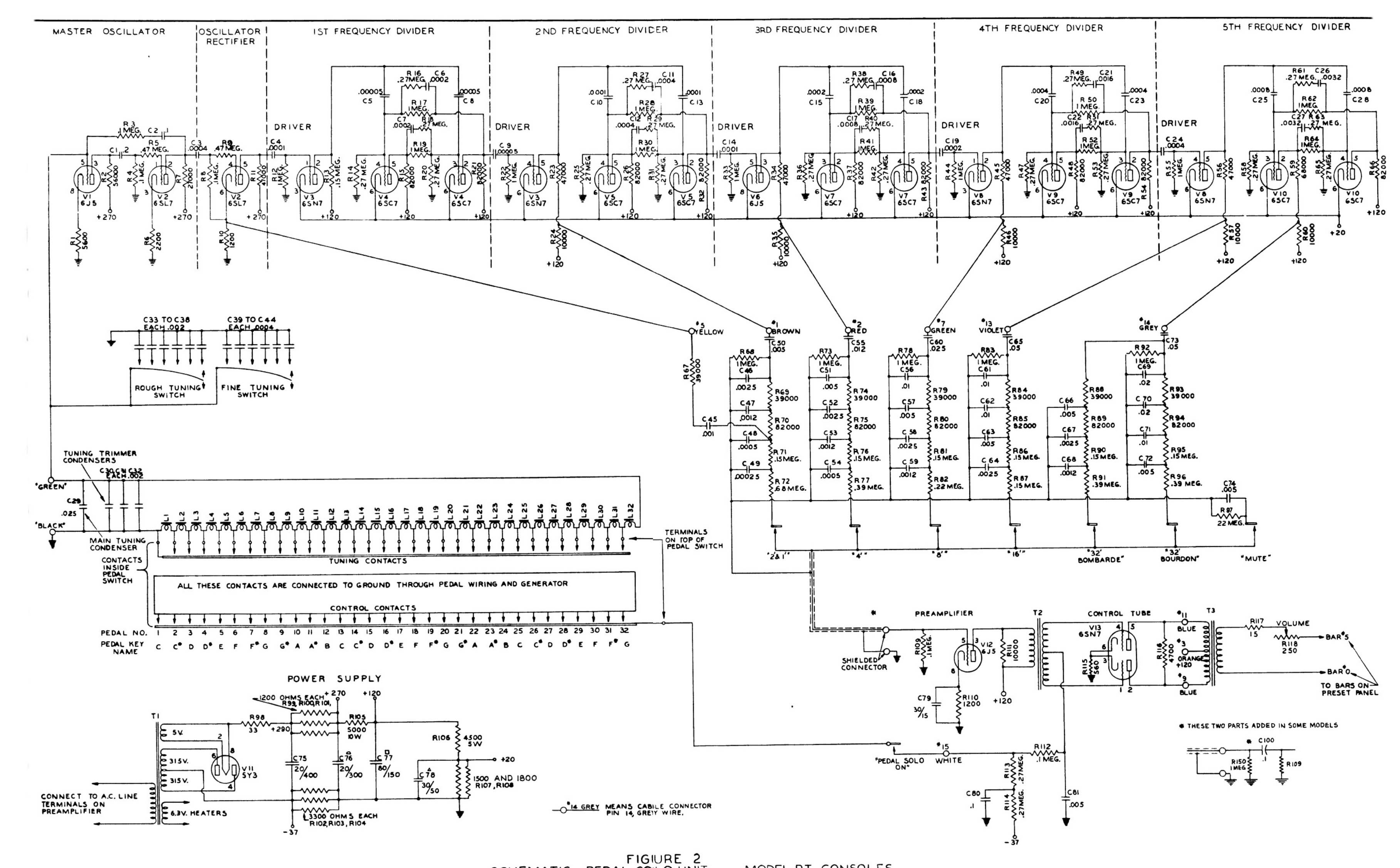


FIGURE 2
SCHEMATIC - PEDAL SOLO UNIT - MODEL RT CONSOLES
PEDAL SOLO GENERATOR TYPE RTA

MODEL RT CONSOLES NO. 1000 TO 1201
MODEL RT-2 CONSOLES NO. 1300 AND ABOVE

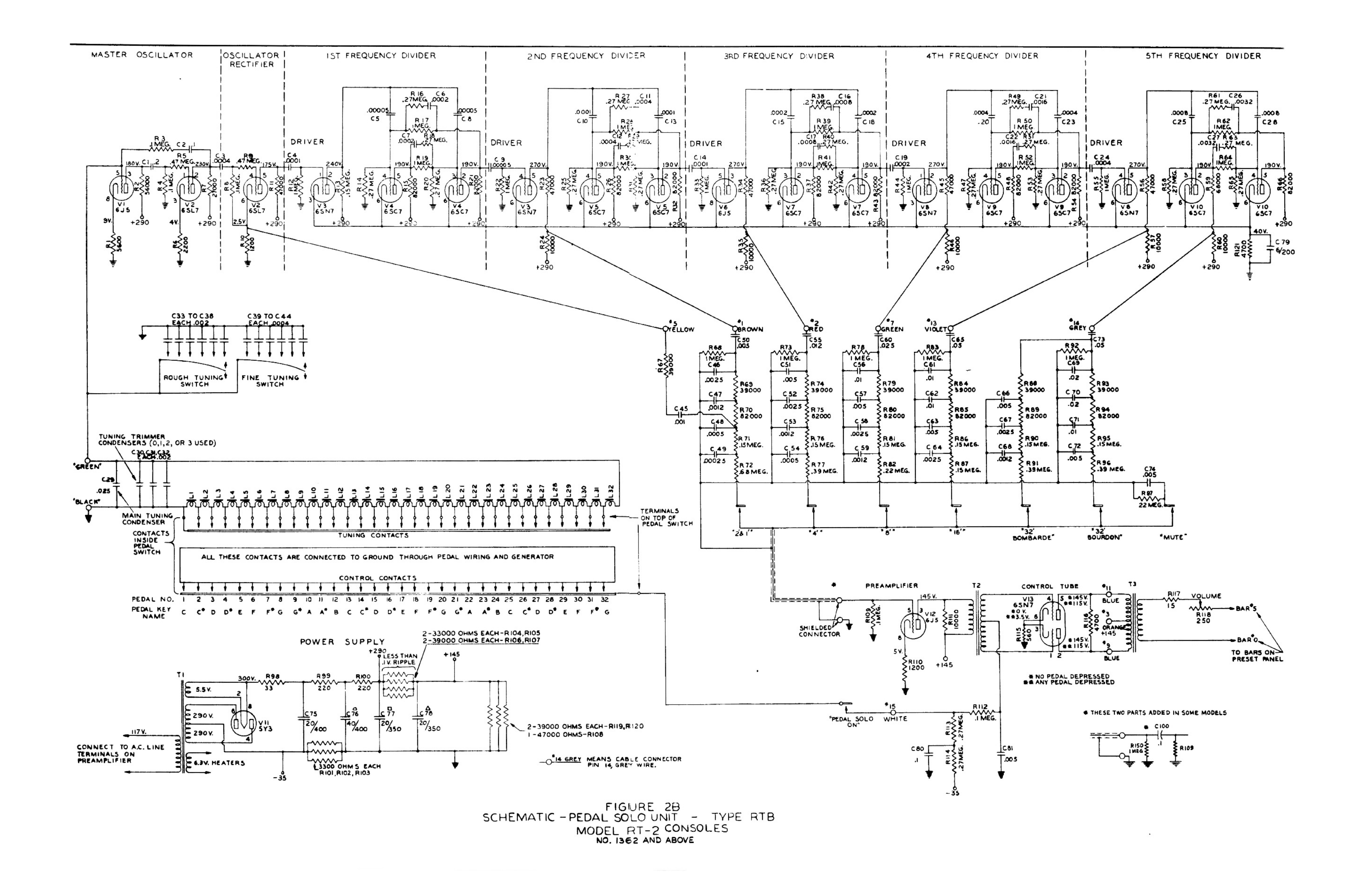


FIGURE 2B
SCHEMATIC - PEDAL SOLO UNIT - TYPE RTB
MODEL RT-2 CONSOLES
NO. 1362 AND ABOVE

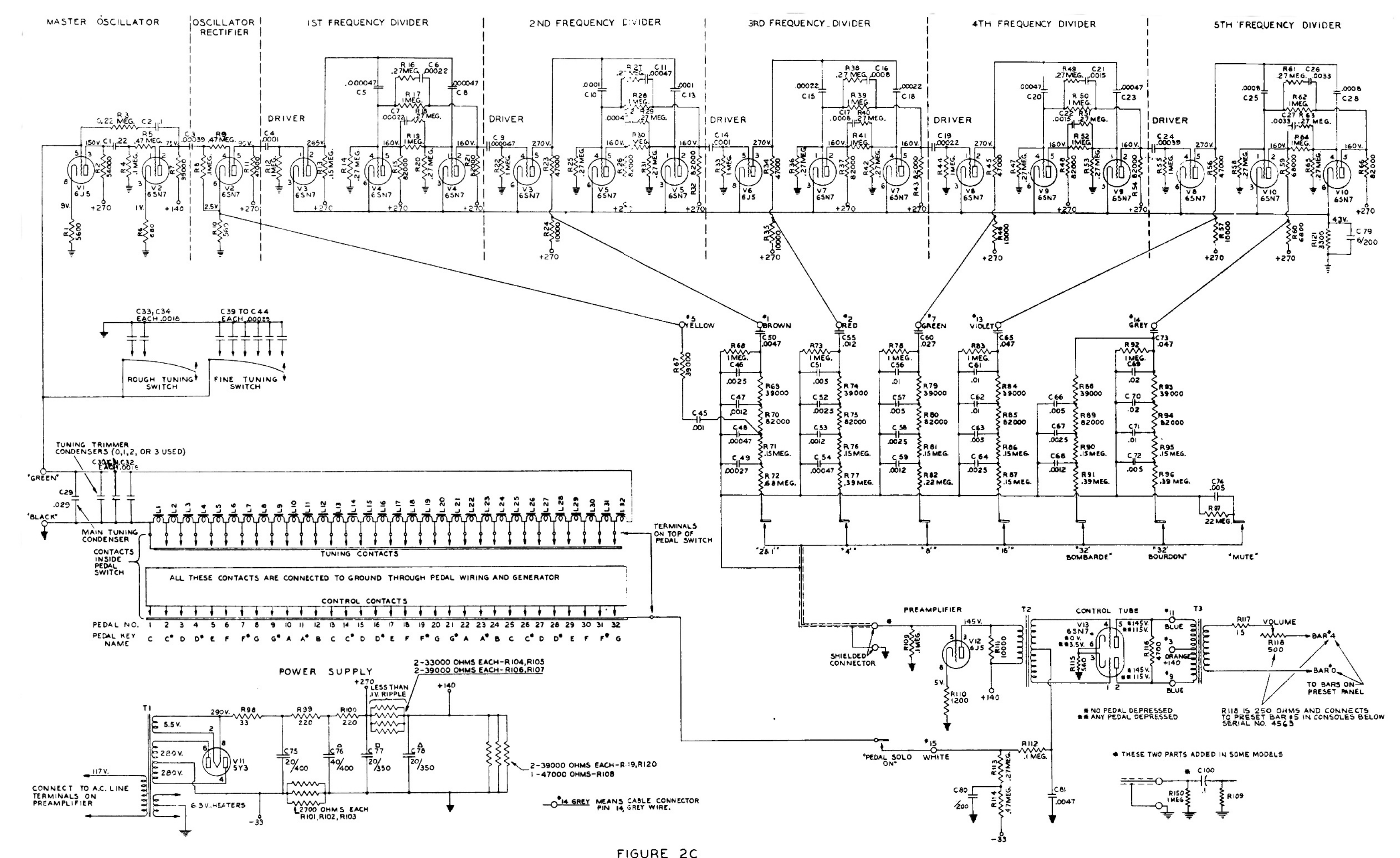
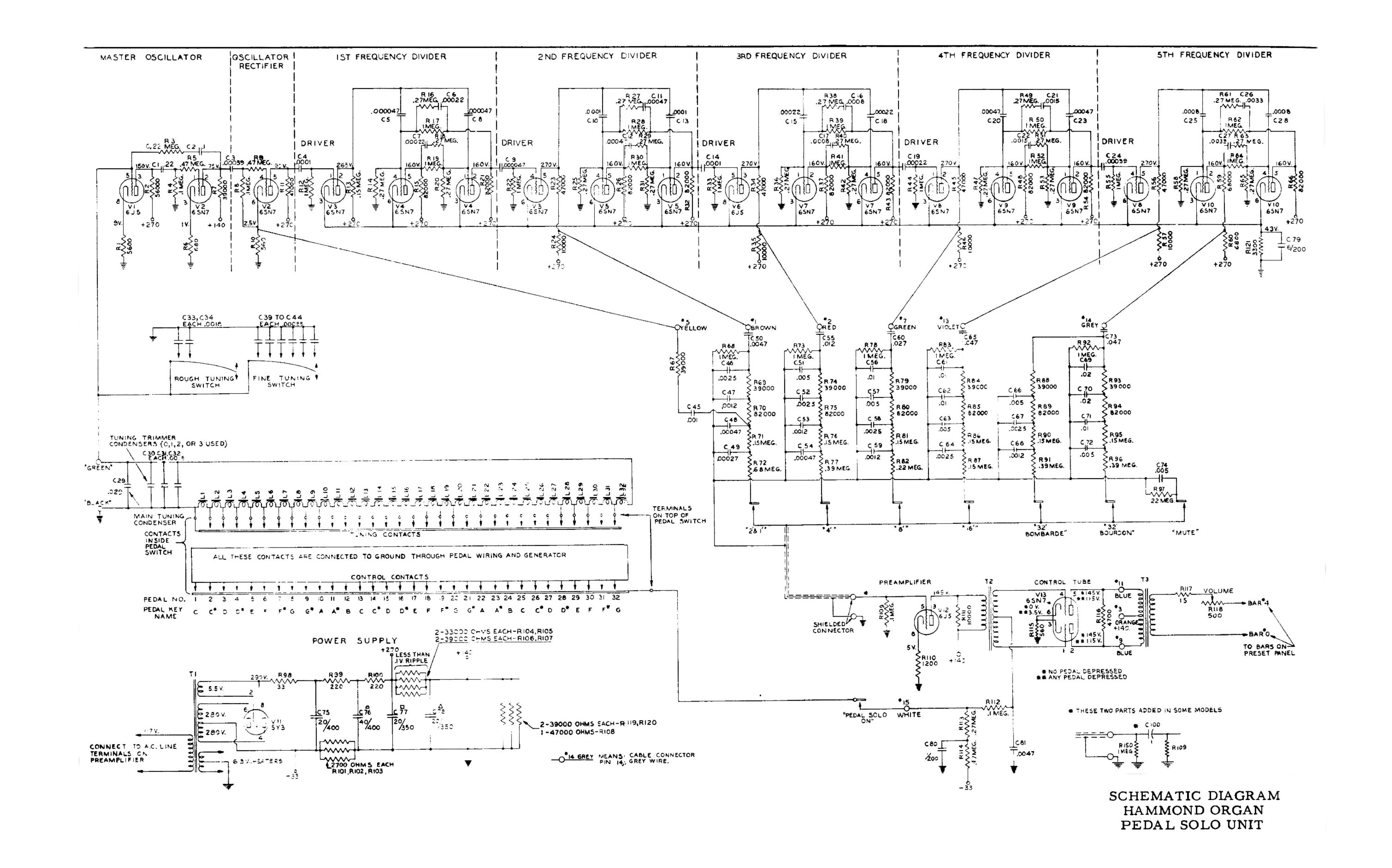
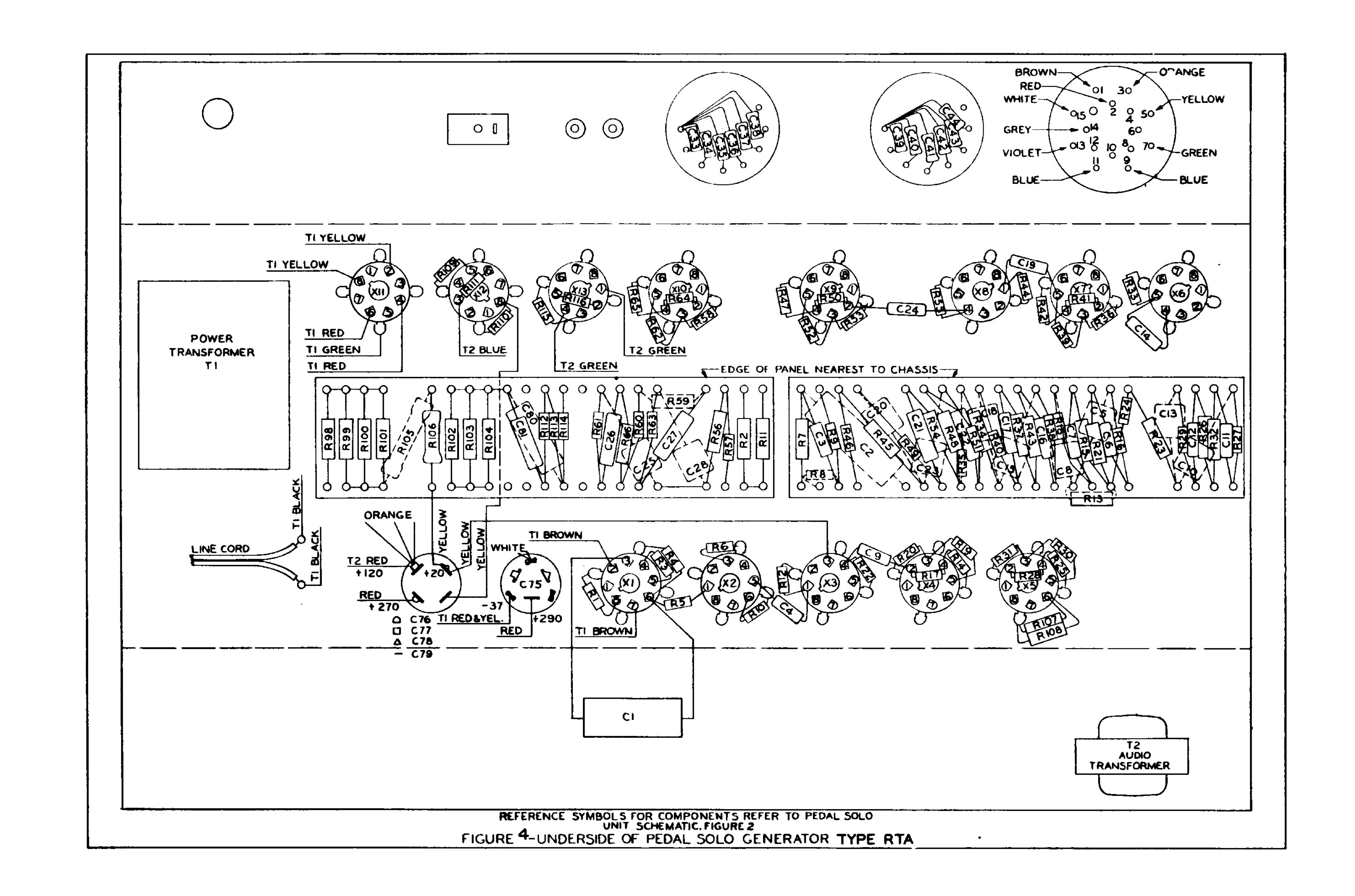


FIGURE 2C
SCHEMATIC - PEDAL SOLO UNIT - TYPES RTC, RTD, RTE
MODEL RT-2 AND RT-3 CONSOLES

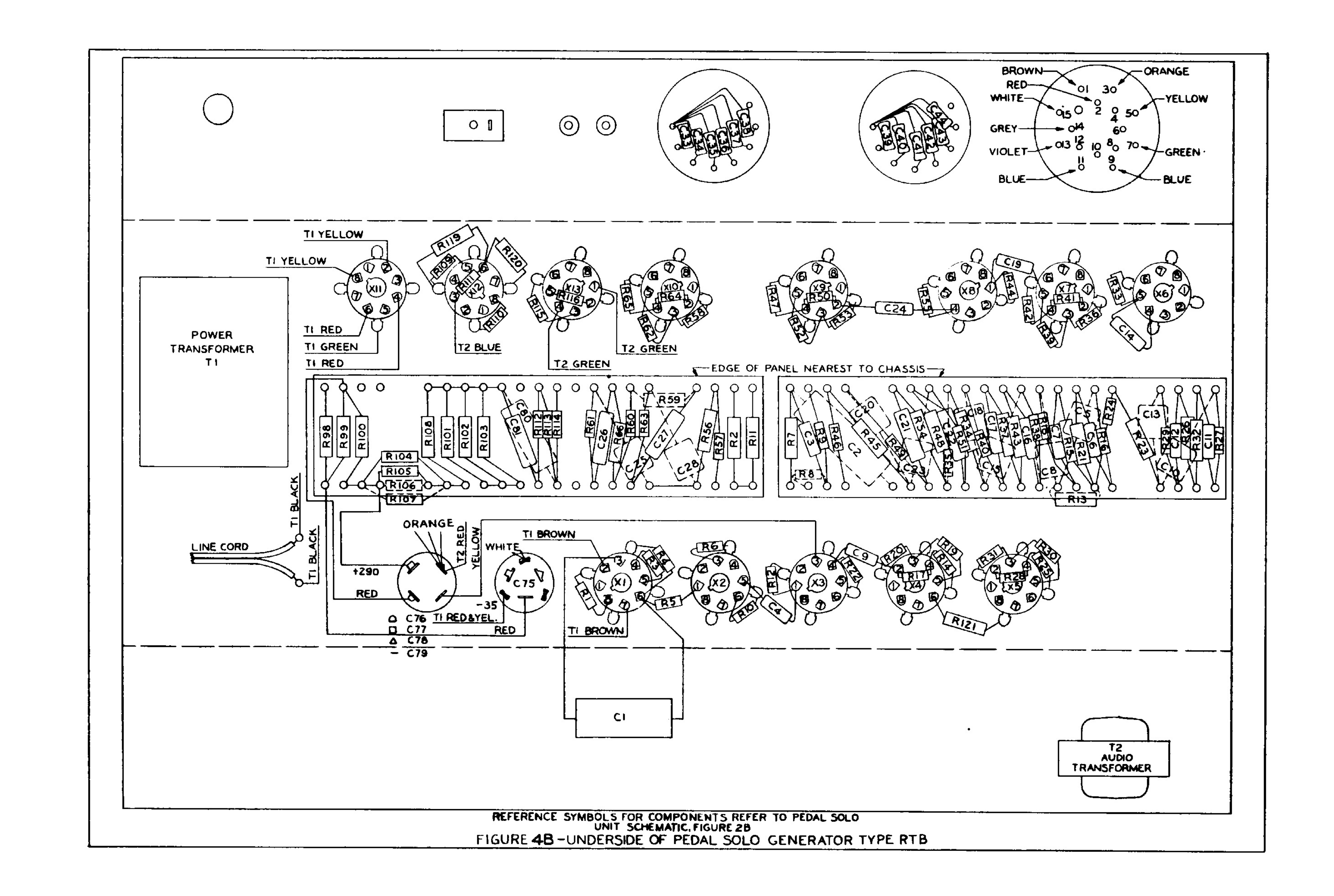


SCHEMATIC DIAGRAM
HAMMOND ORGAN
PEDAL SOLO UNIT



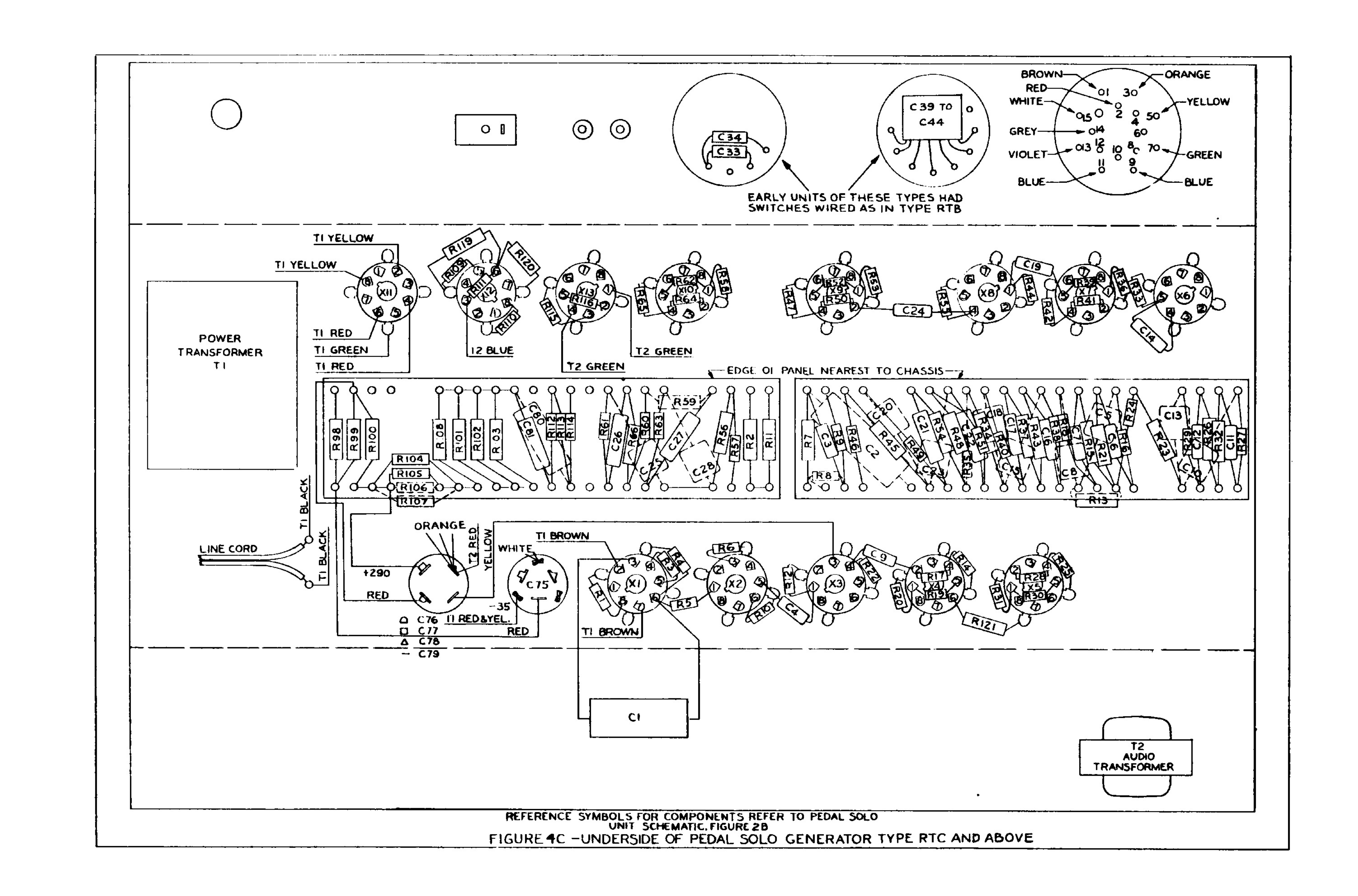
REFERENCE SYMBOLS FOR COMPONENTS REFER TO PEDAL SOLO UNIT SCHEMATIC, FIGURE 2

FIGURE 4-UNDERSIDE OF PEDAL SOLO GENERATOR TYPE RTA



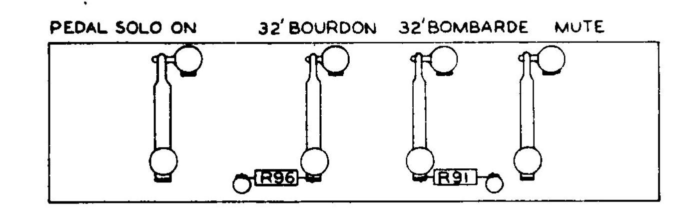
REFERENCE SYMBOLS FOR COMPONENTS REFER TO PEDAL SOLO UNIT SCHEMATIC, FIGURE 2B

FIGURE 4B - UNDERSIDE OF PEDAL SOLO GENERATOR TYPE RTB



REFERENCE SYMBOLS FOR COMPONENTS REFER TO PEDAL SOLO UNIT SCHEMATIC, FIGURE 2B

FIGURE 4C -UNDERSIDE OF PEDAL SOLO GENERATOR TYPE RTC AND ABOVE



WHITE TO PEDAL SWITCH OR #15
WHITE #15 OR PEDAL SWITCH
R83
C65 C61 C63 R84 R85 R86 C62 C64 R95 R94 R93 C72 C70 C73 C71 R92 C69 C67 R88 R89 C66 R90 C68 R97 C74 R117
T3 BLUE
#9 OR #11 BLUE
T3 BLUE
T3
#13 VIOLET
#14 GREY
T3 GREEN
#11 OR #9 BLUE
R118
GREEN
GREEN
#7 GREEN
#2 RED
#1 BROWN
T3 RED
#3 ORANGE
C 59 R81 C57 R80 C56 R79 C58 C60 C53 R78 C51 R76 R75 C54 R74 C55 C48 C52 R67 R68 C45 R71 R70 C49 R69 C46 C50 C47
R73
T3 BLACK
#5 YELLOW

R87 R82 R77 R72
16' 8' 4' 2'&1'

BLACK TO #0 BUS BAR
GREEN TO #5 BUS BAR

GREY
WHITE
BROWN
RED
ORANGE
YELLOW
GREEN
BLUE
BLUE
VIOLET
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

VIEW OF CABLE SIDE OF PLUG

WHITE TO PEDAL SWITCH

REFERENCE SYMBOLS FOR COMPONENTS REFER TO PEDAL SOLO UNIT SCHEMATIC, FIGURE 2

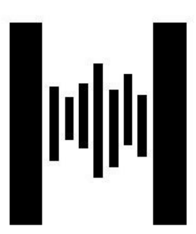
FIGURE -UNDERSIDE OF PEDAL SOLO CONTROL PANEL

THE HAMMOND ORGAN

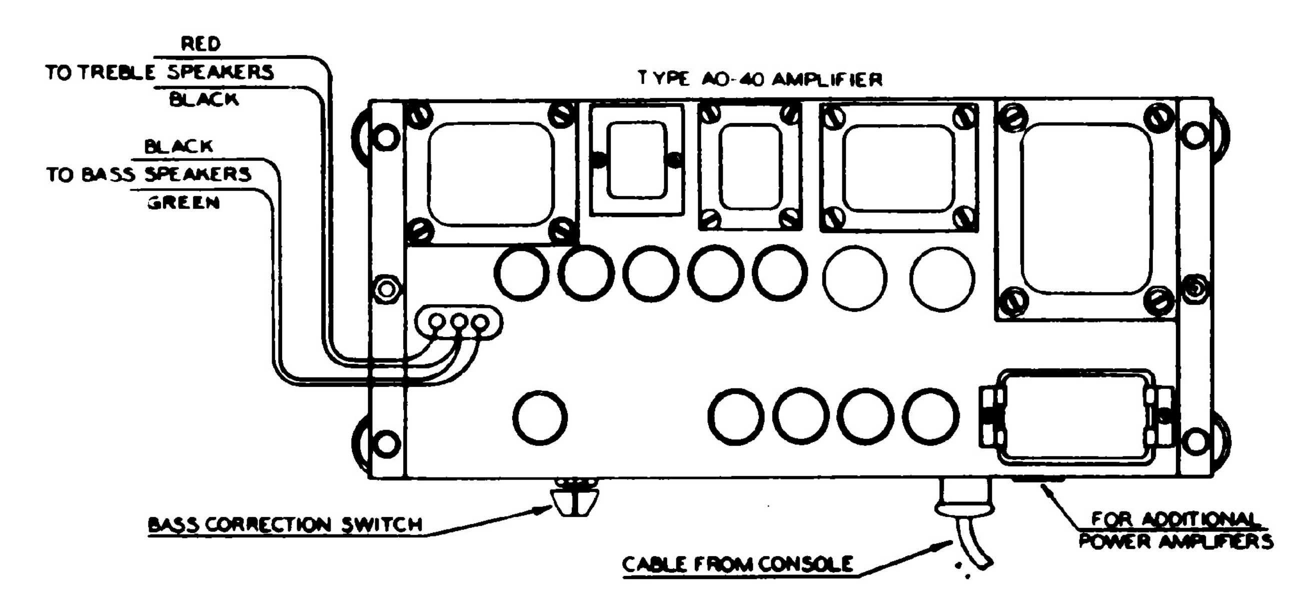
– 16 –

WIRING & SCHEMATIC
DIAGRAMS

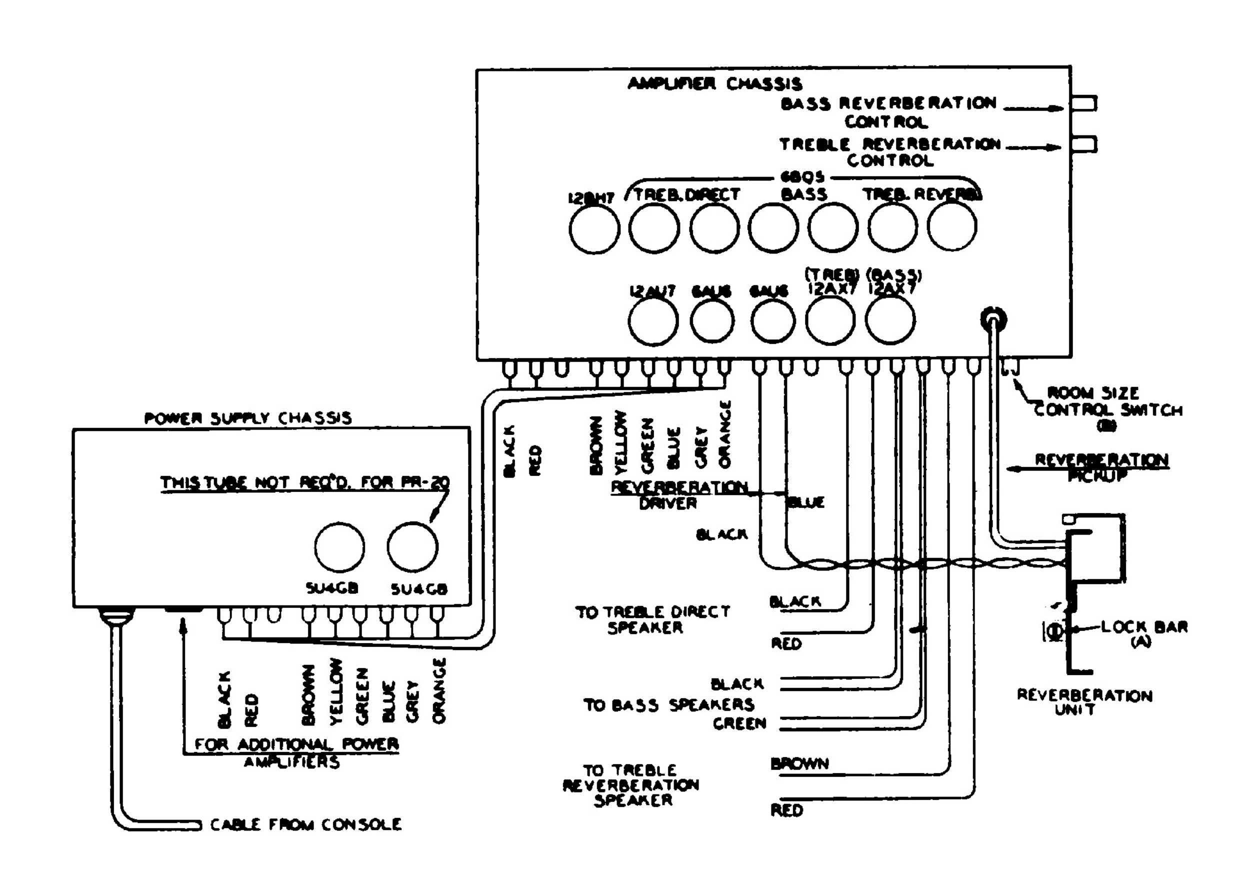
PART 5 - TONE CABINET
PRE, POWER & REVERBERATION AMPLIFIERS



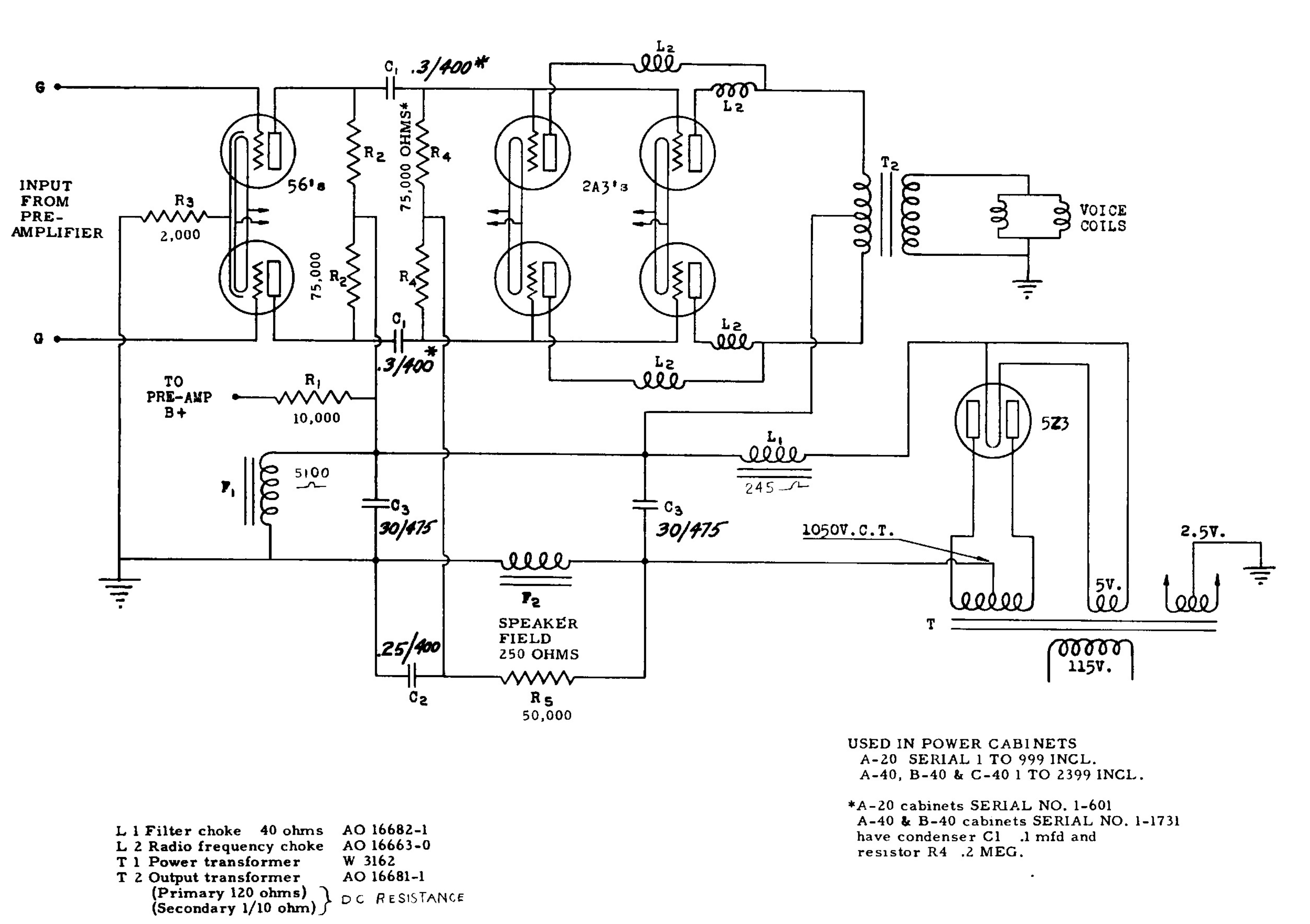
HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA



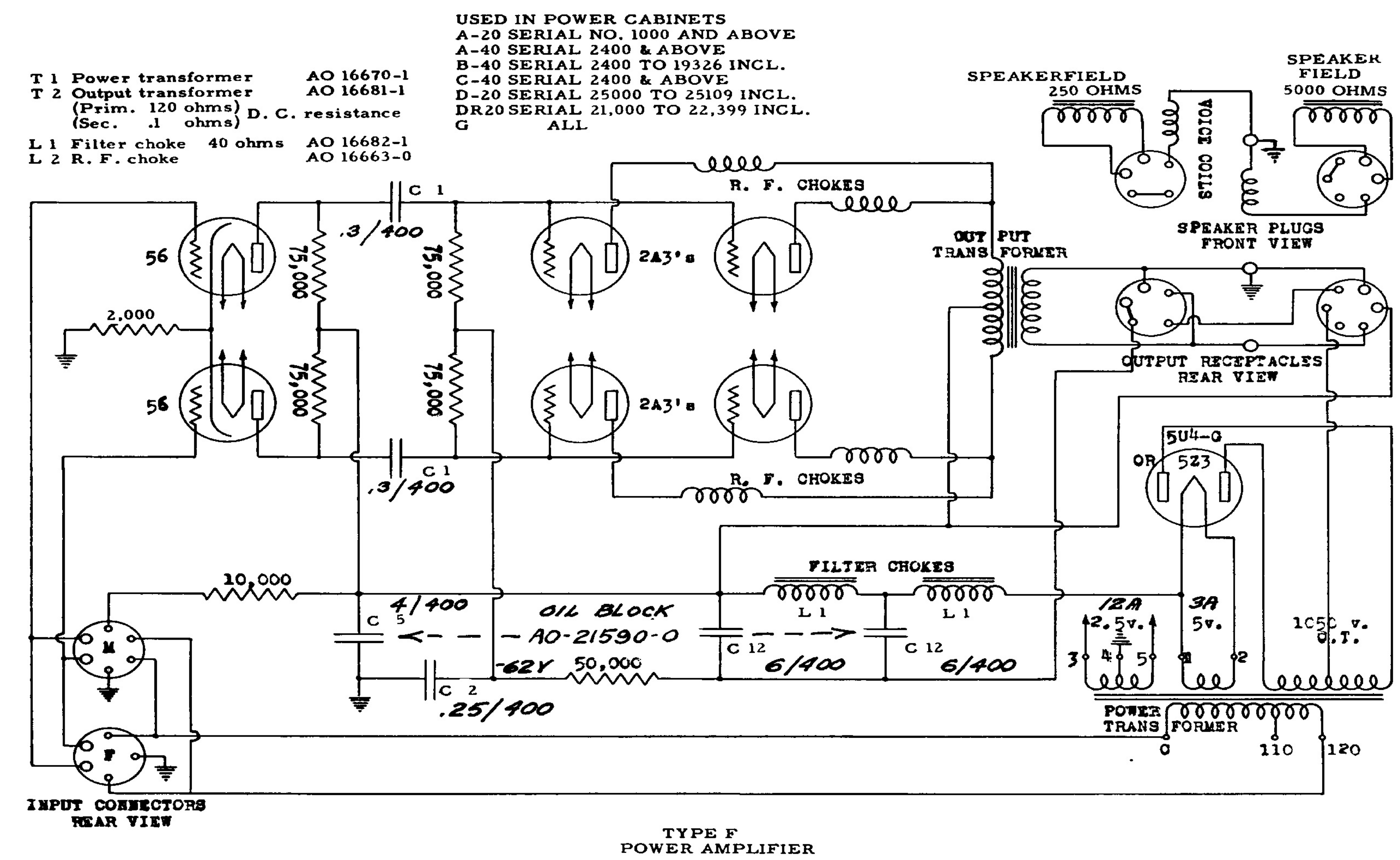
Block Diagram - P based Amplifier



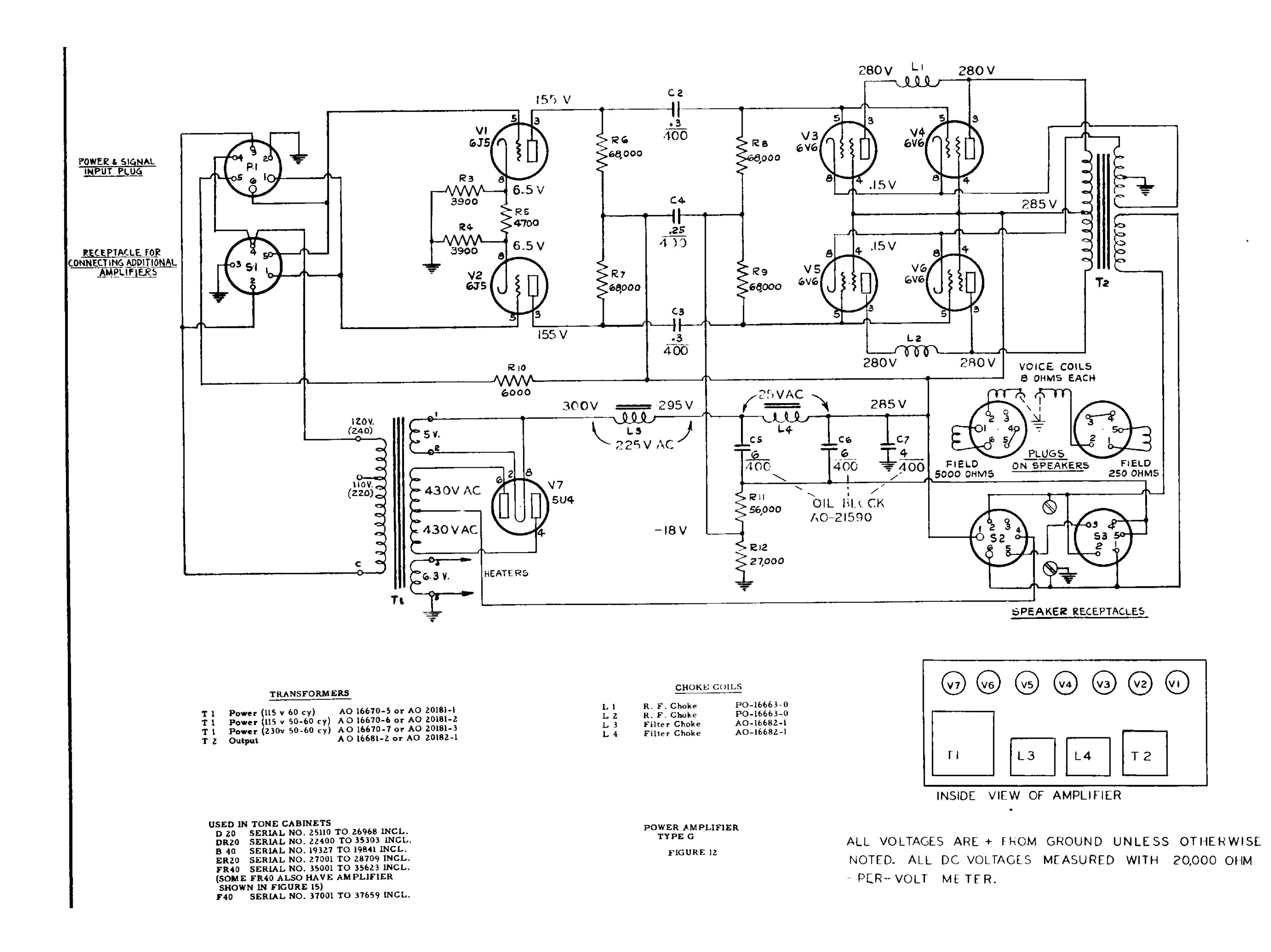
Block Diagram - PR based Amplifier



PRE AMPLIFIER
FIGURE 10

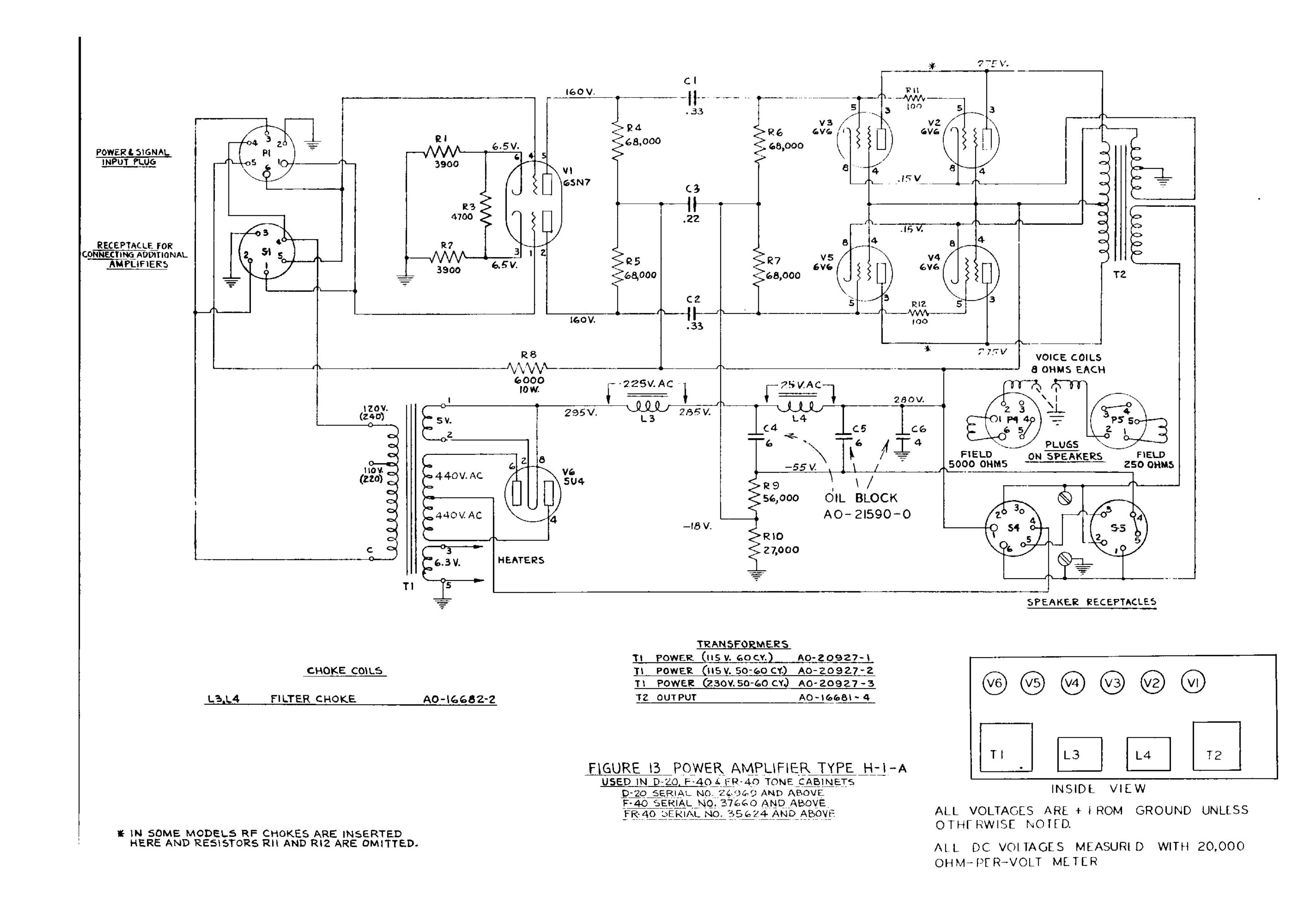


TYPE F
POWER AMPLIFIER
FIGURE 11



POWER AMPLIFIER
TYPE G

FIGURE 12



TRANSFORMERS

T1	POWER (115 V. 60 CY.)	AO-20927-1
T1	POWER (115 V. 50-60 CY.)	AO-20927-2
T1	POWER (230 V. 50-60 CY.)	AO-20927-3
T2	OUTPUT	AO-16681-4

CHOKE COILS

L3, L4	FILTER CHOKE	AO-16682-2

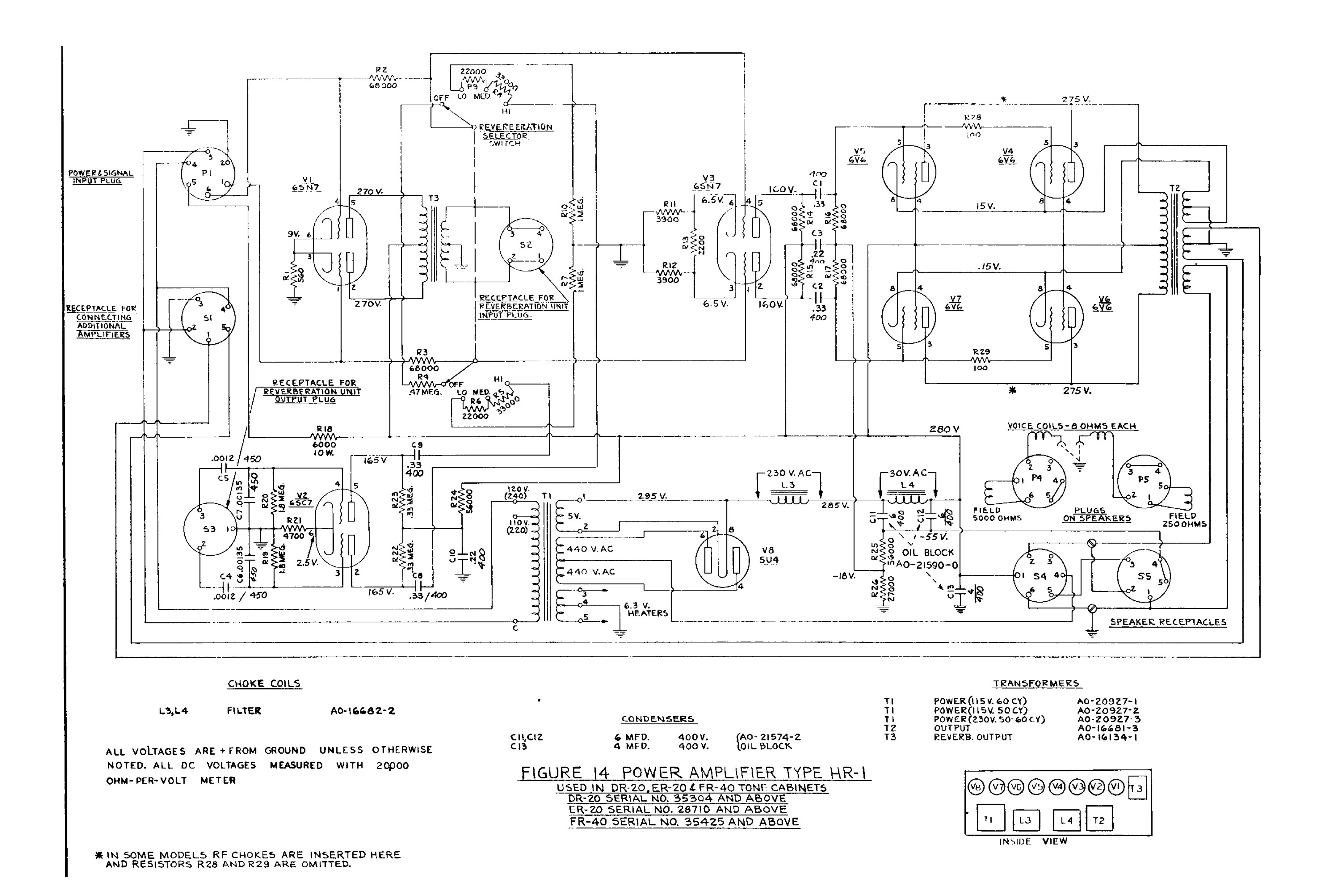
INSIDE VIEW

FIGURE 13 POWER AMPLIFIER TYPE H-1-A
USED IN D-20, F-40 & FR-40 TONE CABINETS
D-20 SERIAL NO. 26969 AND ABOVE
F-40 SERIAL NO. 37660 AND ABOVE
FR-40 SERIAL NO. 35624 AND ABOVE

ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED.

ALL DC VOLTAGES MEASURED WITH 20,000 OHM-PER-VOLT METER

* IN SOME MODELS RF CHOKES ARE INSERTED HERE AND RESISTORS R11 AND R12 ARE OMITTED.



CHOKE COILS

L3,L4	FILTER	AO-16682-2

CONDENSERS

C11,C12	6 MFD.	400 V.	(AO-21574-2
C13	4 MFD.	400 V.	OIL BLOCK

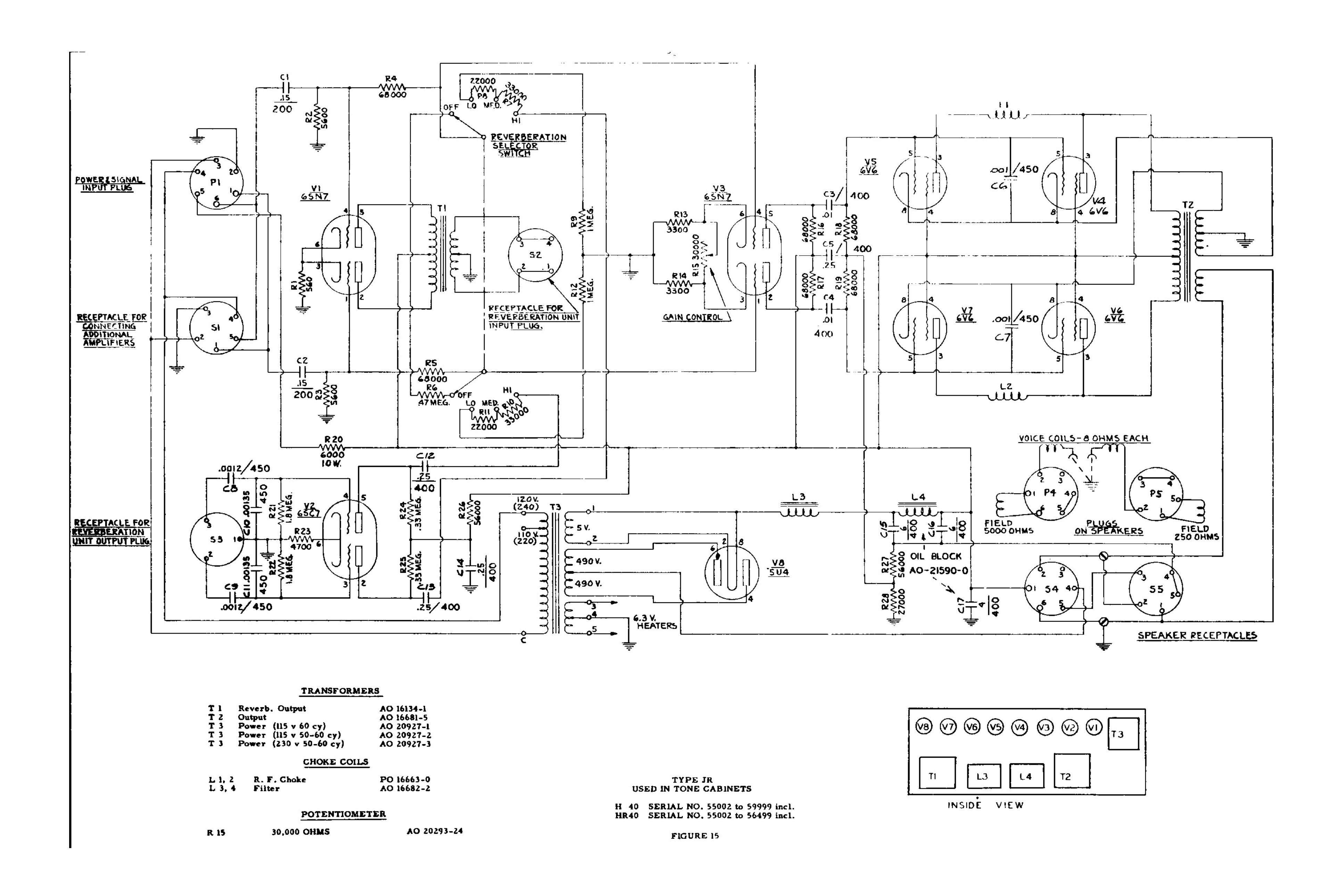
TRANSFORMERS

T1	POWER (115 V. 60 CY)	AO-20927-1
T1	POWER (115 V. 50 CY)	AO-20927-2
T1	POWER (230 V. 50-60 CY)	AO-20927-3
T2	OUTPUT	AO-16681-3
T3	REVERB. OUTPUT	AO-16134-1

ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED. ALL DC VOLTAGES MEASURED WITH 20,000 OHM-PER-VOLT METER

FIGURE 14 POWER AMPLIFIER TYPE HR-1
USED IN DR-20, ER-20 & FR-40 TONE CABINETS
DR-20 SERIAL NO. 35304 AND ABOVE
ER-20 SERIAL NO. 28710 AND ABOVE
FR-40 SERIAL NO. 35425 AND ABOVE

* IN SOME MODELS RF CHOKES ARE INSERTED HERE AND RESISTORS R28 AND R29 ARE OMITTED.



TRANSFORMERS

T 1	Reverb. Output	AO 16134-1
T 2	Output	AO 16681-5
T 3	Power (115 v 60 cy)	AO 20927-1
T 3	Power (115 v 50-60 cy)	AO 20927-2
T 3	Power (230 v 50-60 cy)	AO 20927-3

CHOKE COILS

L 1, 2	R. F. Choke	PO 16663-0
L 3, 4	Filter	AO 16682-2

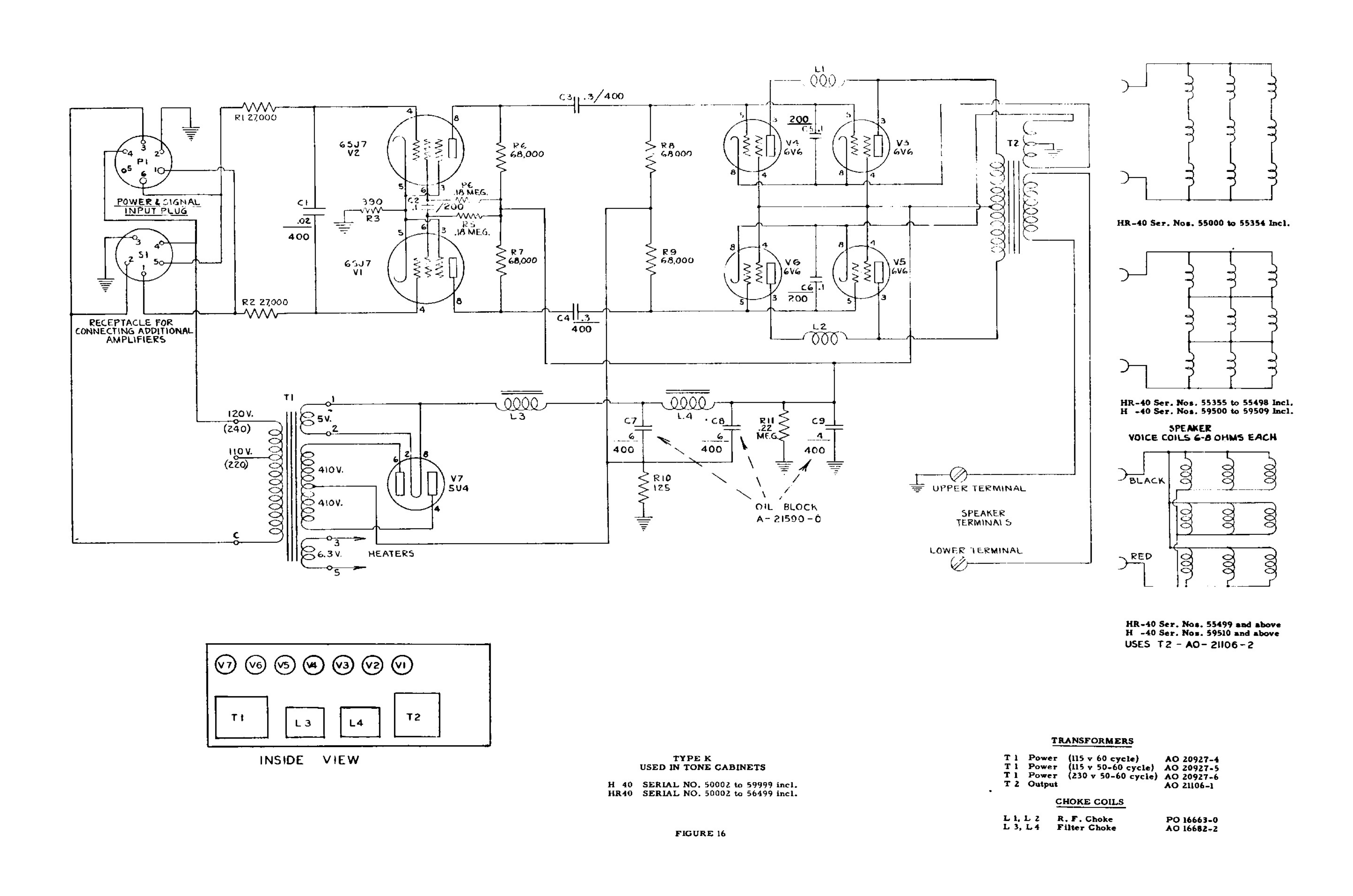
POTENTIOMETER

R 15	30,000 OHMS	AO 20293-24

TYPE JR
USED IN TONE CABINETS

H 40 SERIAL NO. 55002 to 59999 incl.
HR40 SERIAL NO. 55002 to 56499 incl.

FIGURE 15



TYPE K
USED IN TONE CABINETS

H 40 SERIAL NO. 50002 to 59999 incl.
HR40 SERIAL NO. 50002 to 56499 incl.

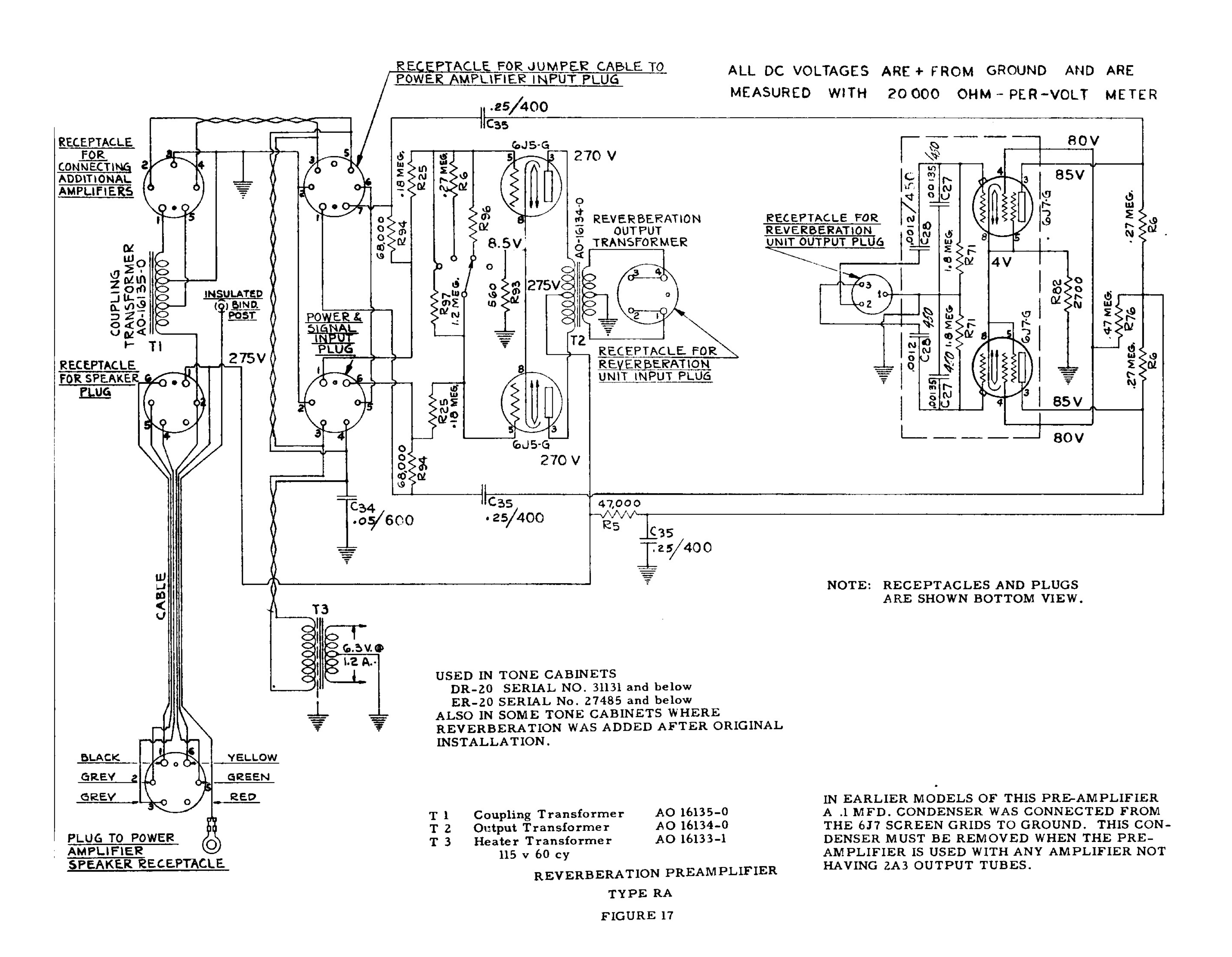
FIGURE 16

TRANSFORMERS

T 1	Power	(115 v 60 cycle)	AO 20927-4
T 1	Power	(115 v 50-60 cycle)	AO 20927-5
T 1	Power	(230 v 50-60 cycle)	AO 20927-6
T 2	Output		AO 21106-1

CHOKE COILS

L 1, L 2	R. F. Choke	PO 16663-0
L 3, L 4	Filter Choke	AO 16682-2



NOTE: RECEPTACLES AND PLUGS ARE SHOWN BOTTOM VIEW.

USED IN TONE CABINETS
DR-20 SERIAL NO. 31131 and below
ER-20 SERIAL No. 27485 and below
ALSO IN SOME TONE CABINETS WHERE REVERBERATION WAS ADDED AFTER ORIGINAL INSTALLATION.

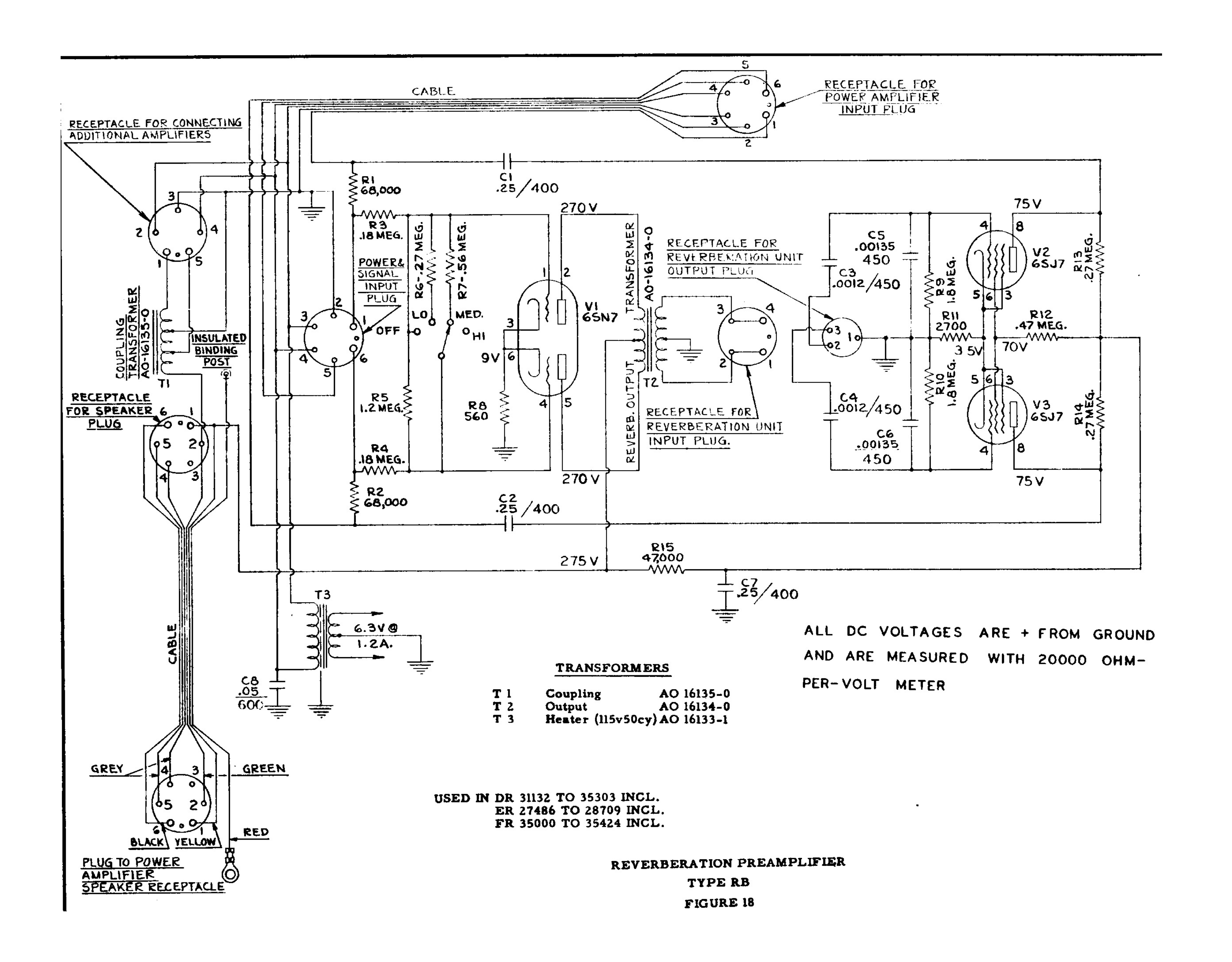
T 1	Coupling Transformer	AO 16135-0
T 2	Output Transformer	AO 16134-0
T 3	Heater Transformer 115 v 60 cy	AO 16133-1

IN EARLIER MODELS OF THIS PRE-AMPLIFIER A .1 MFD. CONDENSER WAS CONNECTED FROM THE 6J7 SCREEN GRIDS TO GROUND. THIS CONDENSER MUST BE REMOVED WHEN THE PRE-AMPLIFIER IS USED WITH ANY AMPLIFIER NOT HAVING 2A3 OUTPUT TUBES.

REVERBERATION PREAMPLIFIER

TYPE RA

FIGURE 17



REVERBERATION PREAMPLIFIER

TYPE RB

FIGURE 18

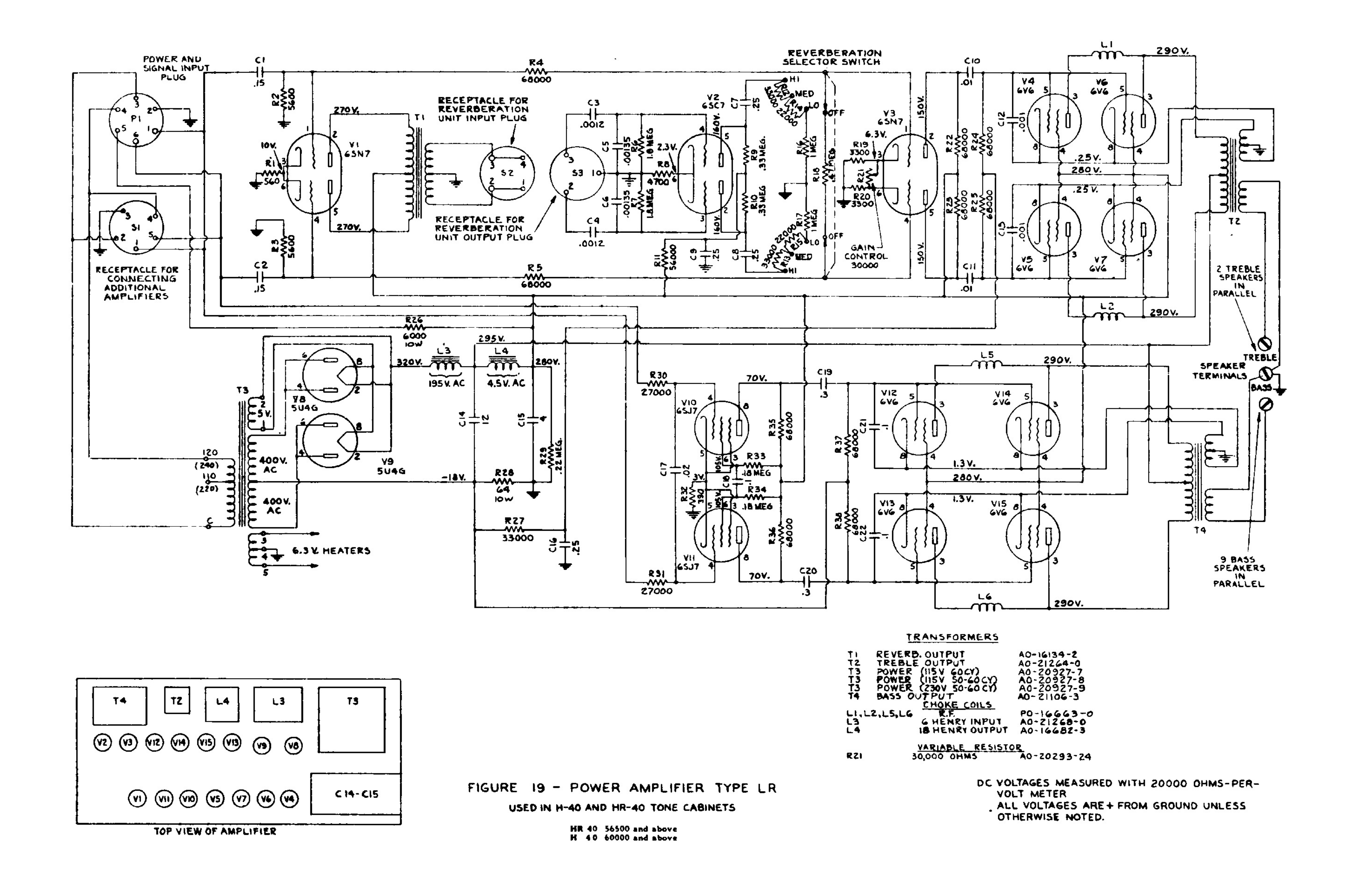


FIGURE 19 - POWER AMPLIFIER TYPE LR

USED IN H-40 AND HR-40 TONE CABINETS

HR 40 56500 and above
H 40 60000 and above

TRANSFORMERS

T1	REVERB. OUTPUT	A0-16134-2
T2	TREBLE OUTPUT	A0-21264-0
T3	POWER (115V 60CY)	A0-20927-7
T3	POWER (115V 50-60CY)	A0-20927-8
T3	POWER (230V 50-60CY)	A0-20927-9
T4	BASS OUTPUT	A0-21106-3
	CHOKE COILS	
L1, L2, L5, L6	R.F.	P0-16663-0
L3	6 HENRY INPUT	A0-21268-0
L4	18 HENRY OUTPUT	A0-16682-3
	VARIABLE RESISTOR	
R21	30,000 OHMS	A0-20293-24

DC VOLTAGES MEASURED WITH 20000 OHMS-PER-VOLT METER

. ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED.

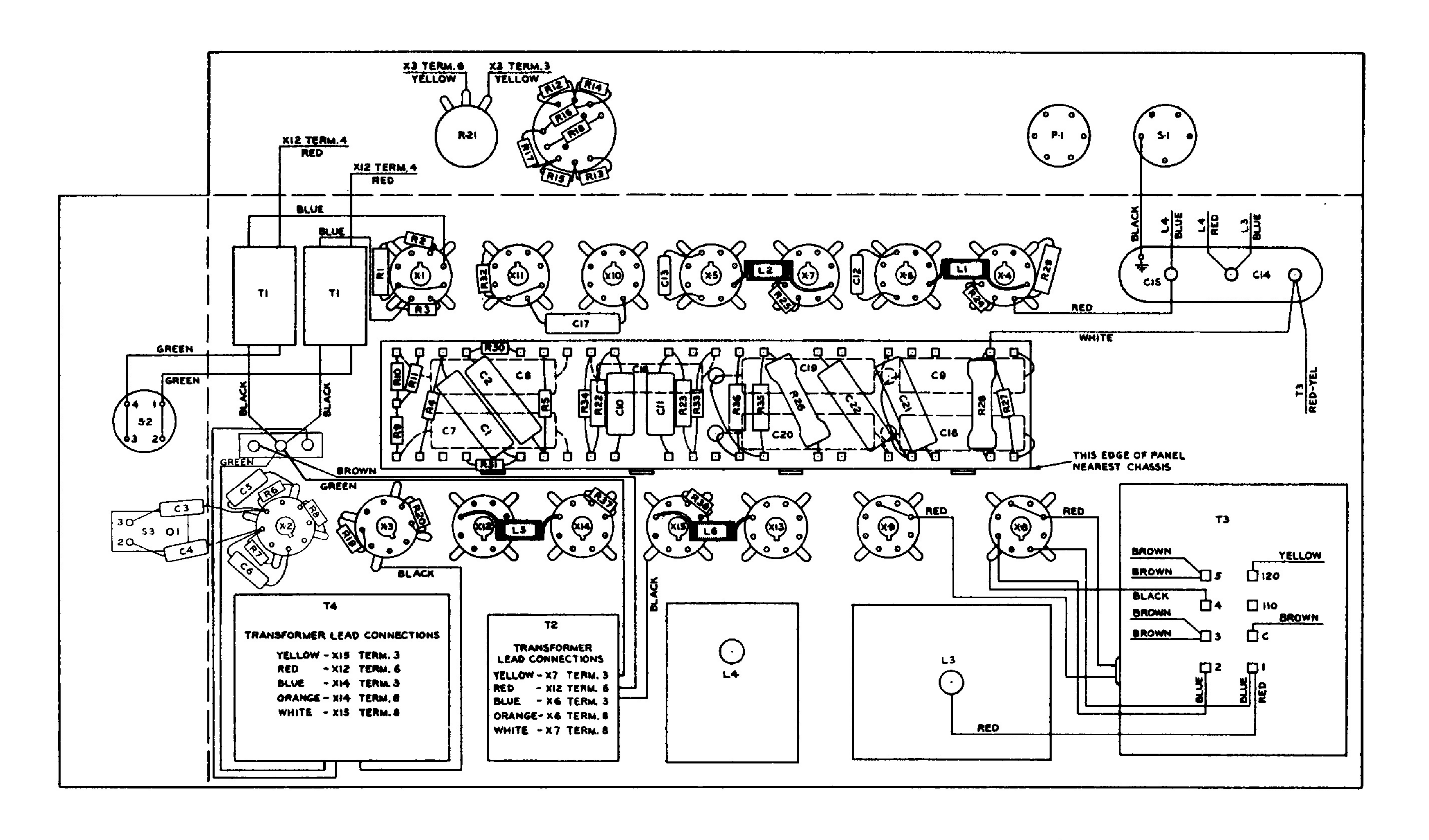


FIGURE 19A - TYPE LR POWER AMPLIFIER
VIEW INSIDE OF CHASSIS

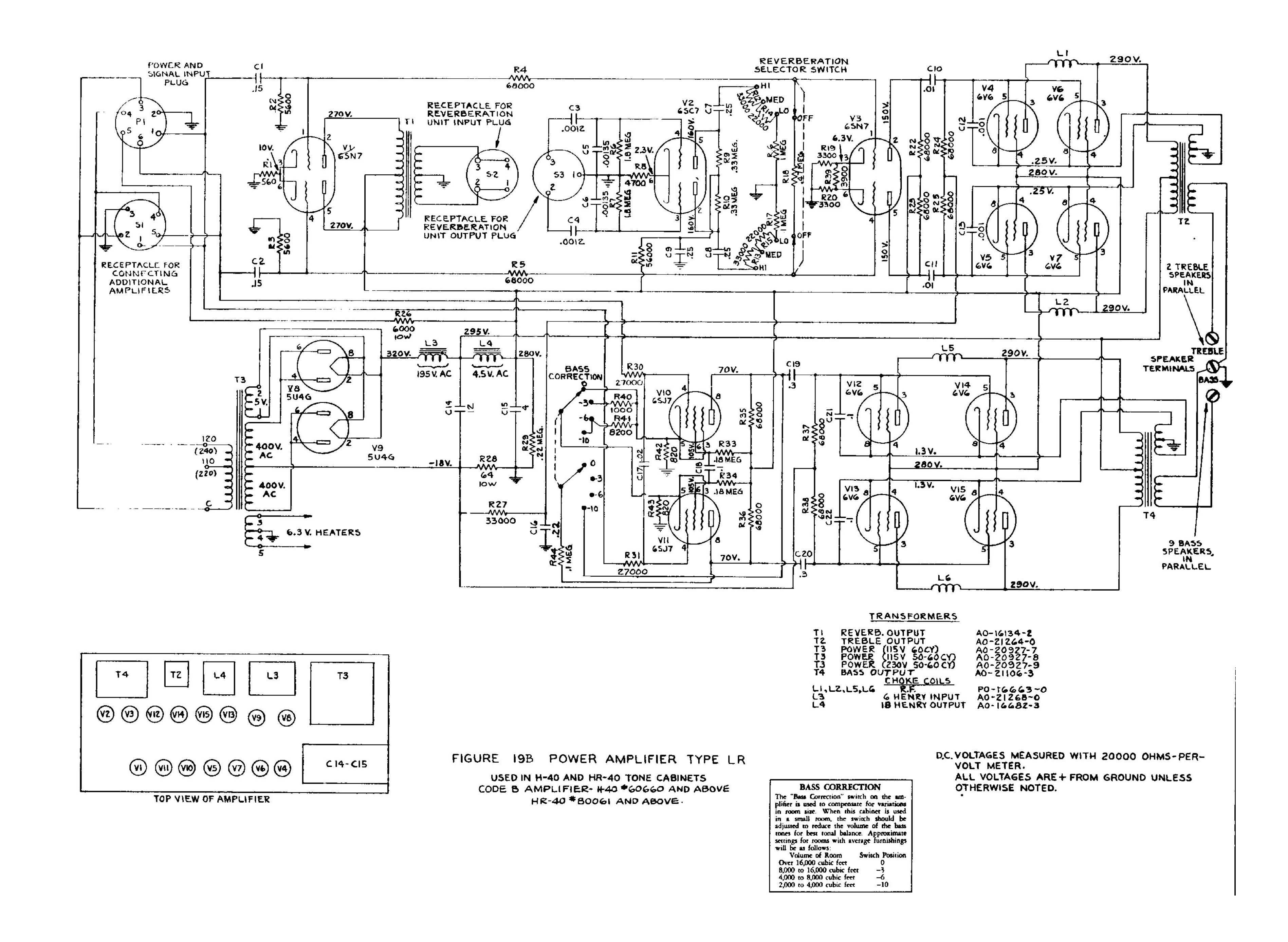


FIGURE 19B POWER AMPLIFIER TYPE LR

USED IN H-40 AND HR-40 TONE CABINETS
CODE B AMPLIFIER- H-40 #60660 AND ABOVE
HR-40 #80061 AND ABOVE.

TRANSFORMERS

T1	REVERB. OUTPUT	AO-16134-2
T2	TREBLE OUTPUT	AO-21264-0
T3	POWER (115V 60CY)	AO-20927-7
T3	POWER (115V 50-60CY)	AO-20927-8
T3	POWER (230V 50-60CY)	AO-20927-9
T4	BASS OUTPUT	AO-21106-3
	CHOKE COILS	
L1,L2,L5,L6	R.F.	PO-16663-0
L3	6 HENRY INPUT	AO-21268-0
L4	18 HENRY OUTPUT	AO-16682-3

D.C. VOLTAGES MEASURED WITH 20000 OHMS-PER-VOLT METER.
ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED.

BASS CORRECTION

The "Bass Correction" switch on the amplifier is used to compensate for variations in room size. When this cabinet is used in a small room, the switch should be adjusted to reduce the volume of the bass tones for best tonal balance. Approximate settings for rooms with average furnishings will be as follows:

Volume of Room	Switch Position
Over 16,000 cubic feet	0
8,000 to 16,000 cubic feet	-3
4,000 to 8,000 cubic feet	-6
2,000 to 4,000 cubic feet	-10

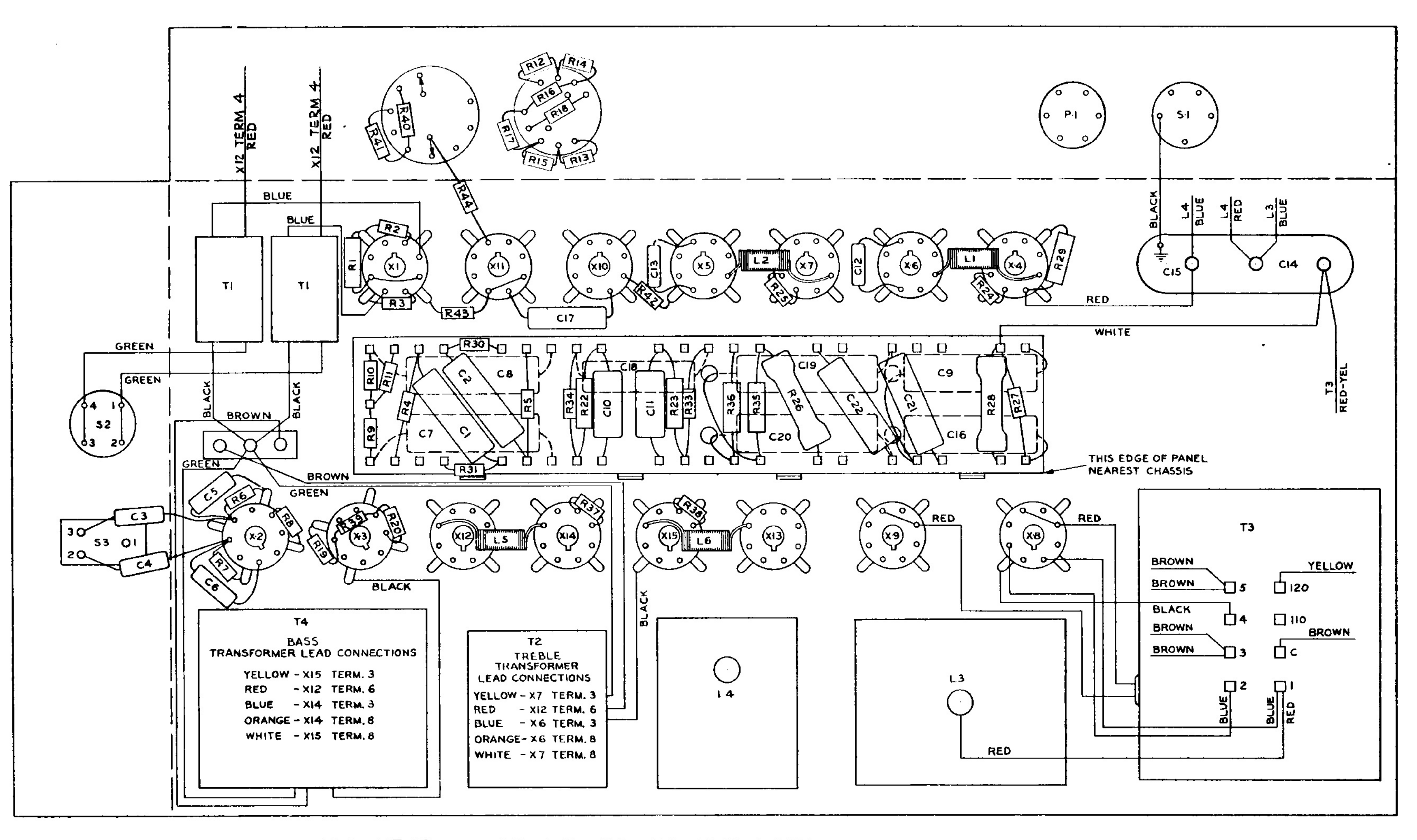


FIGURE 19C - TYPE LR POWER AMPLIFIER
VIEW INSIDE OF CHASSIS

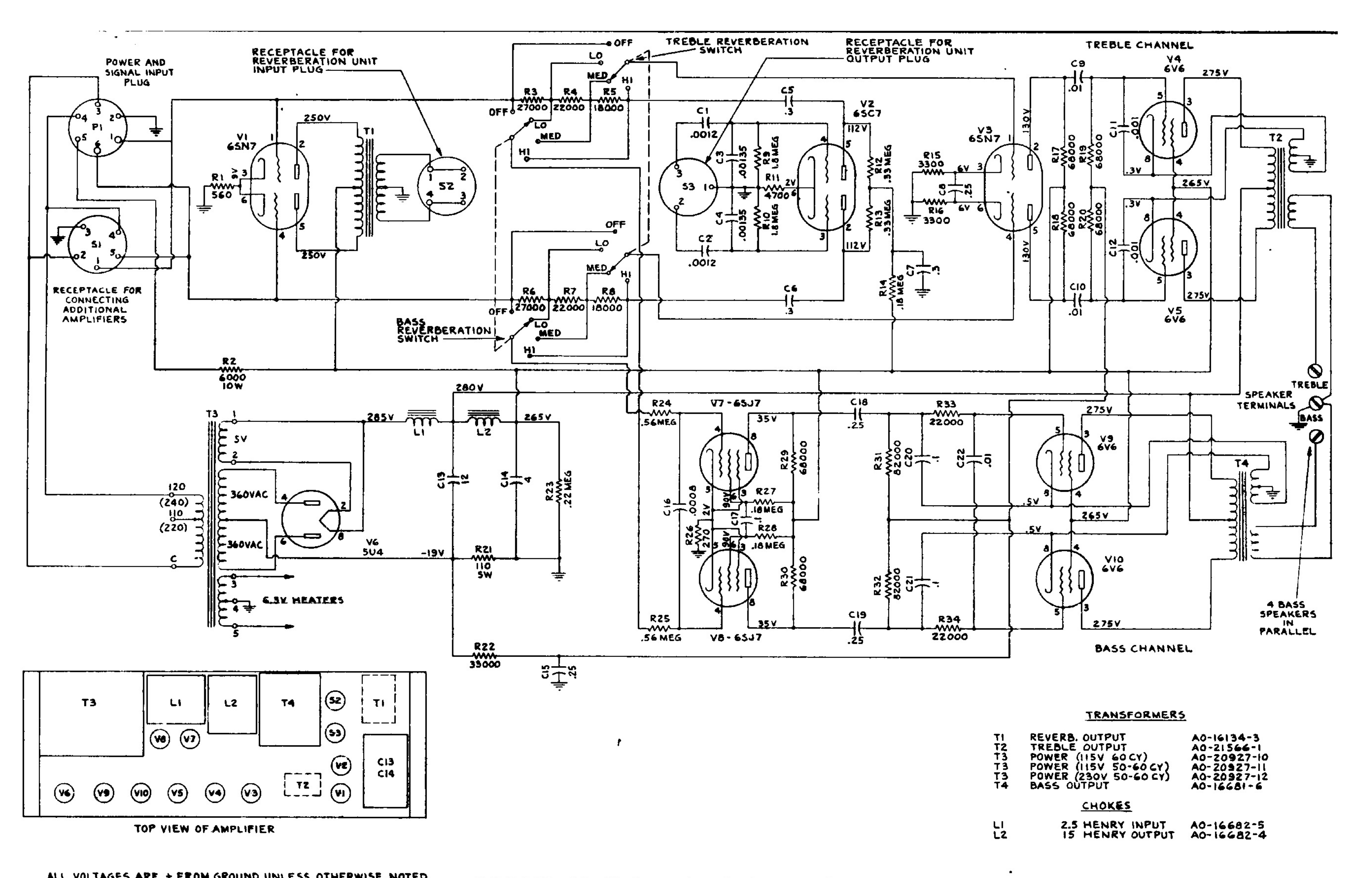
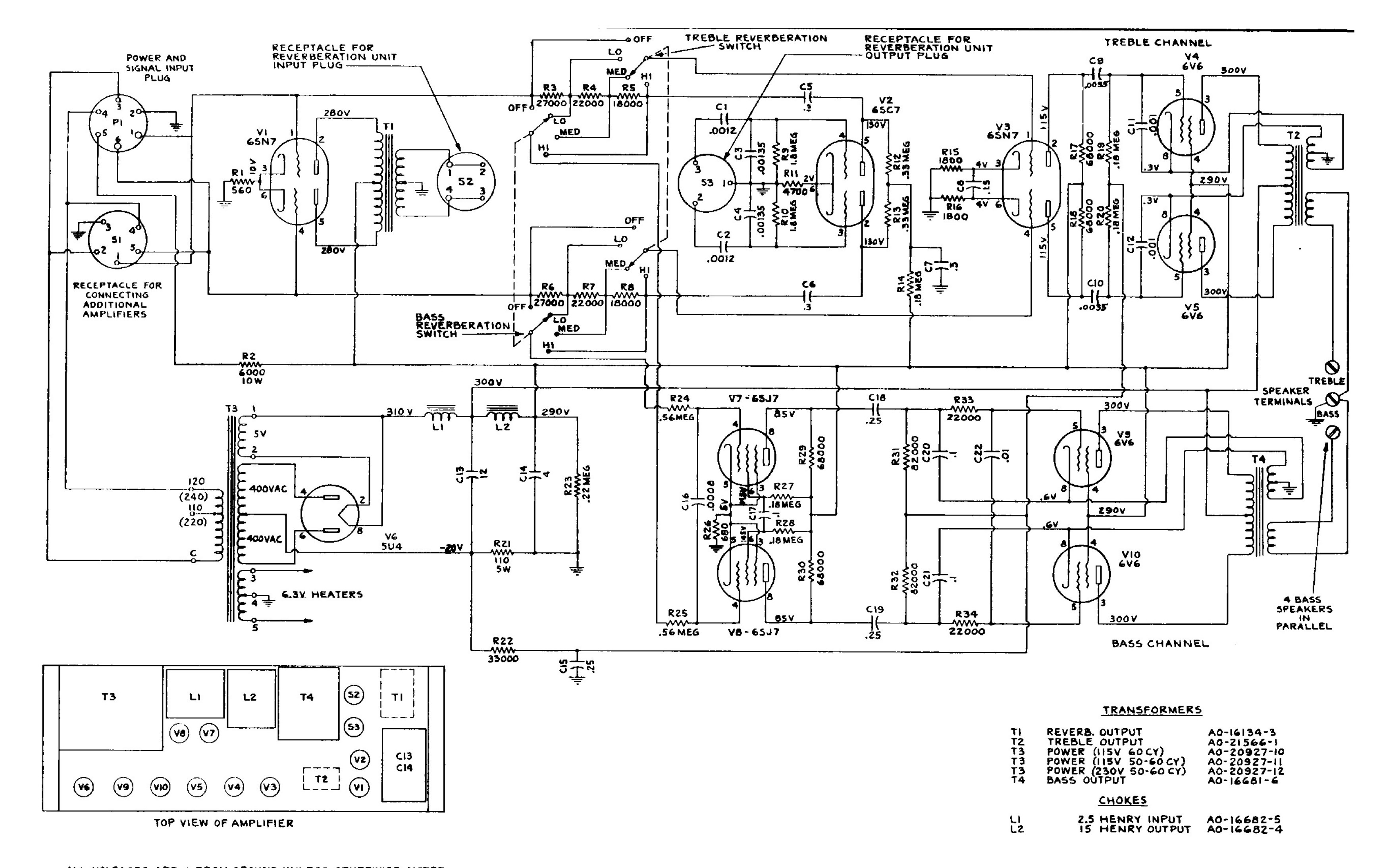


FIGURE 22 - POWER AMPLIFIER TYPE AO-15 (USED IN JR-20 TONE CABINETS) CODE A - SERIAL NOS. 30500 TO 32015



TRANSFORMERS

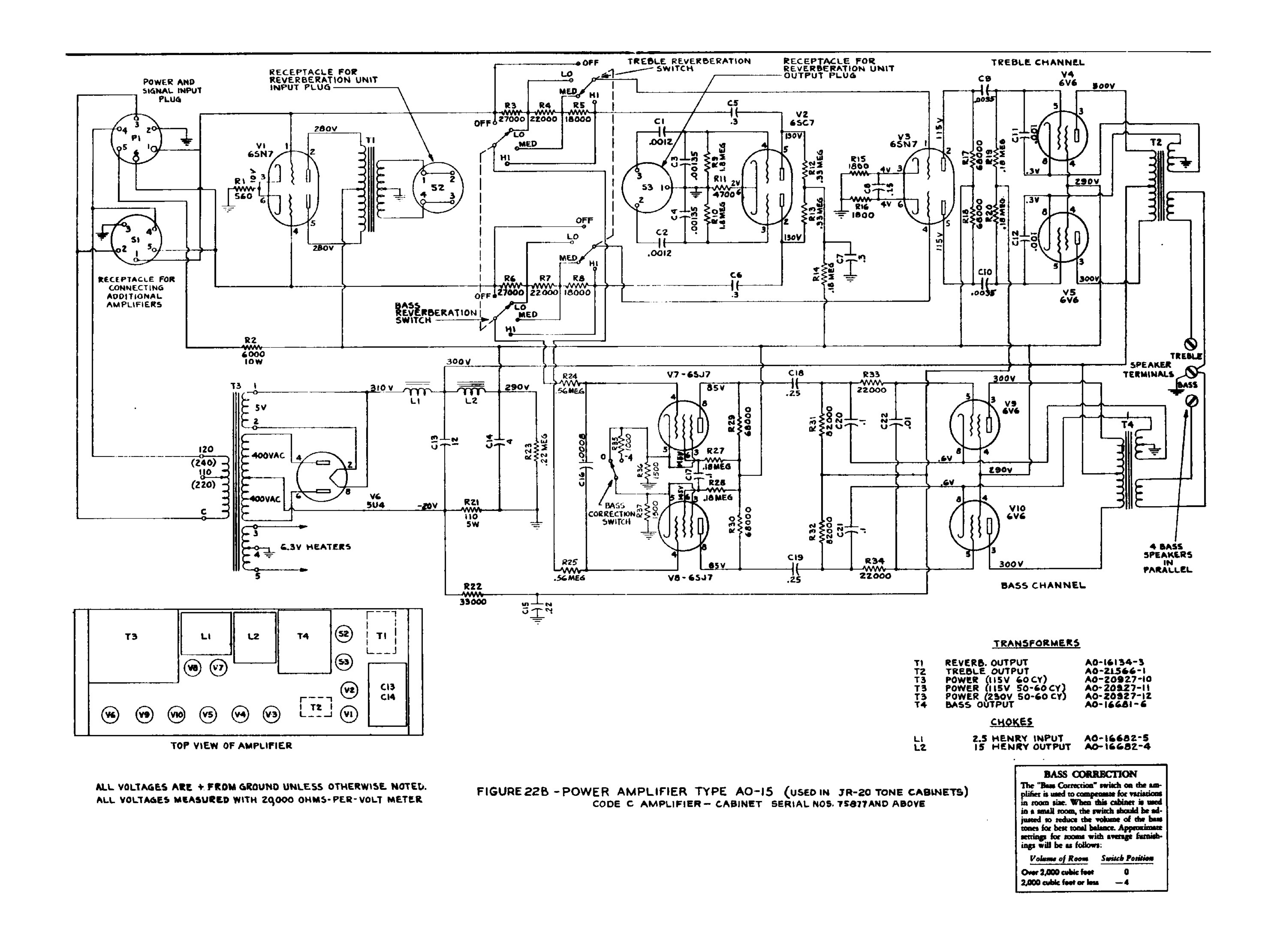
T1	REVERB. OUTPUT	AO-16134-3
T2	TREBLE OUTPUT	AO-21566-1
T3	POWER (115V 60 CY)	AO-20927-10
T3	POWER (115V 50-60 CY)	AO-20927-11
T3	POWER (230V 50-60 CY)	AO-20927-12
T4	BASS OUTPUT	AO-16681-6

CHOKES

L1	2.5 HENRY INPUT	AO-16682-5
L2	15 HENRY OUTPUT	AO-16682-4

ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH 20,000 OHMS-PER-VOLT METER

FIGURE 22A - POWER AMPLIFIER TYPE AO-15 (USED IN JR-20 TONE CABINETS)
CODE B AMPLIFIER - CABINET SERIAL NOS. 32016 AND ABOVE



TRANSFORMERS

T1	REVERB. OUTPUT	AO-16134-3
T2	TREBLE OUTPUT	AO-21566-1
T3	POWER (115V 60CY)	AO-20927-10
T3	POWER (115V 50-60CY)	AO-20927-11
T3	POWER (230V 50-60CY)	AO-20927-12
T4	BASS OUTPUT	AO-16681-6

CHOKES

L1	2.5 HENRY INPUT	AO-16682-5
L2	15 HENRY OUTPUT	AO-16682-4

BASS CORRECTION

The "Bass Correction" switch on the amplifier is used to compensate for variations in room size. When this cabinet is used in a small room, the switch should be adjusted to reduce the volume of the bass tones for best tonal balance. Approximate settings for rooms with average furnishings will be as follows:

Volume of Room	*Switch Position*
Over 2,000 cubic feet	0
2,000 cubic feet or less	—4

ALL VOLTAGES ARE + FROM GROUND UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH 20,000 OHMS-PER-VOLT METER

FIGURE 22B - POWER AMPLIFIER TYPE AO-15 (USED IN JR-20 TONE CABINETS)
CODE C AMPLIFIER - CABINET SERIAL NOS. 75877 AND ABOVE

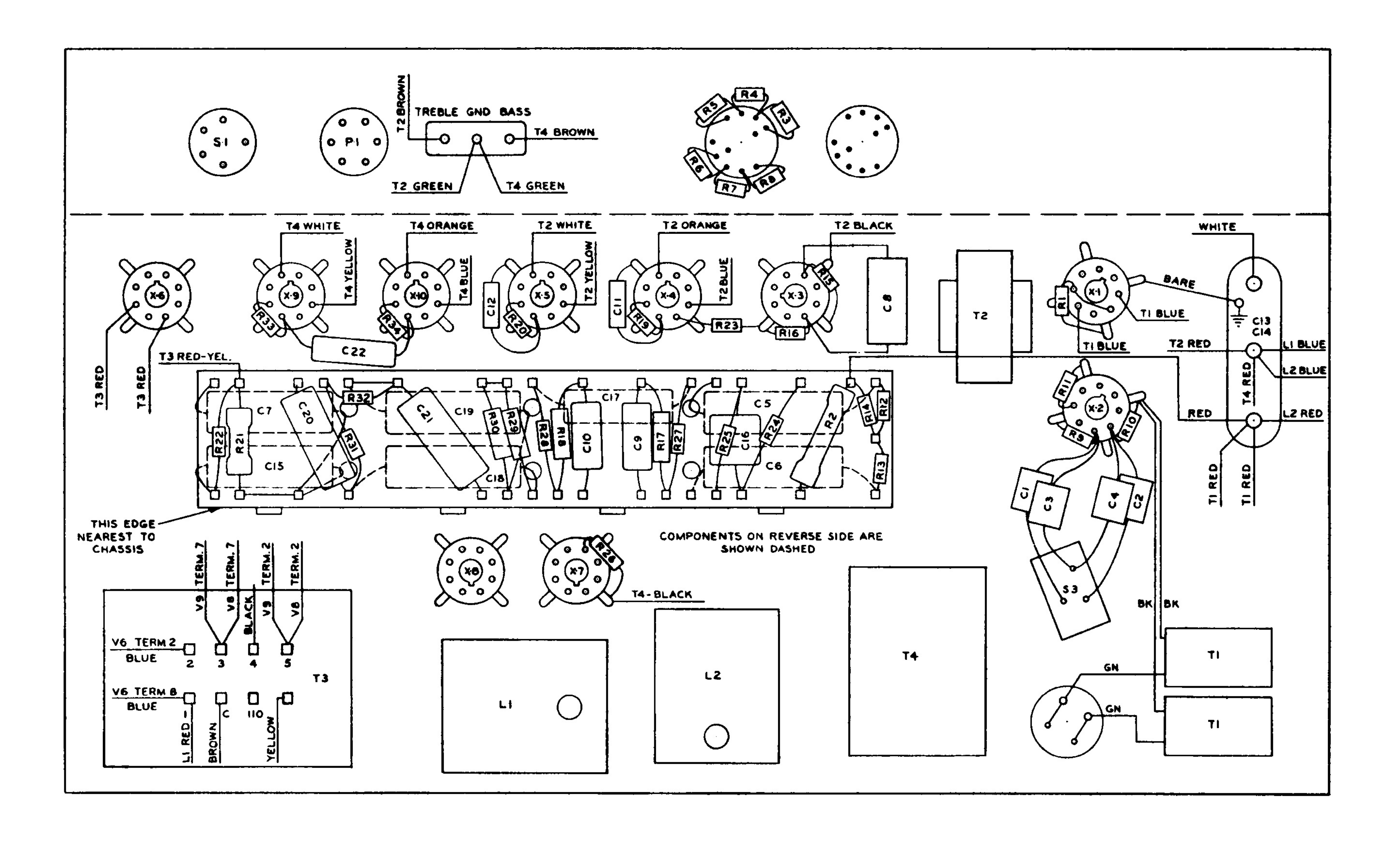


FIGURE 23
INSIDE VIEW OF AO-15 AMPLIFIER
SHOWING LOCATION OF COMPONENTS

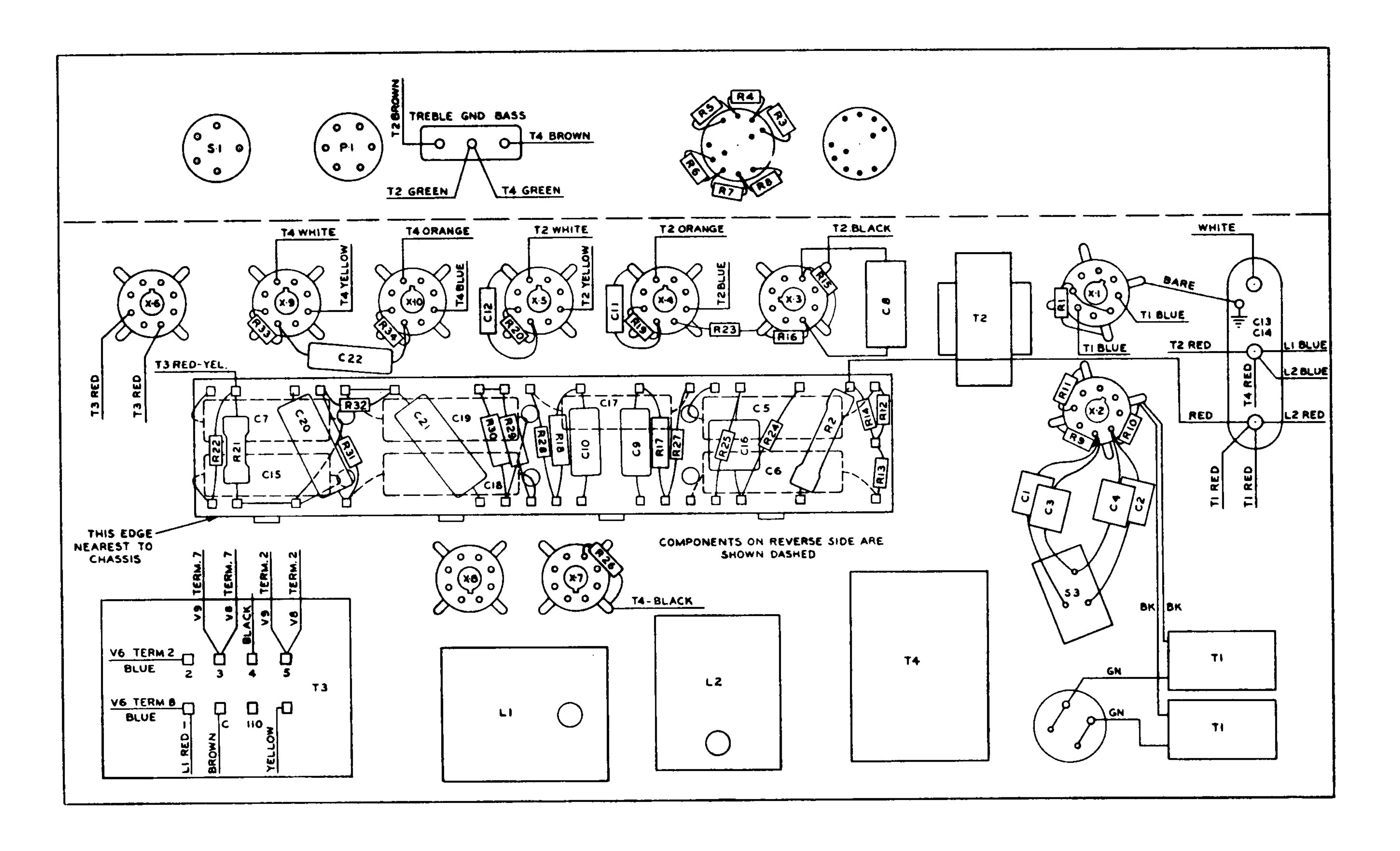


FIGURE 23 A
INSIDE VIEW OF AO-15 AMPLIFIER
SHOWING LOCATION OF COMPONENTS

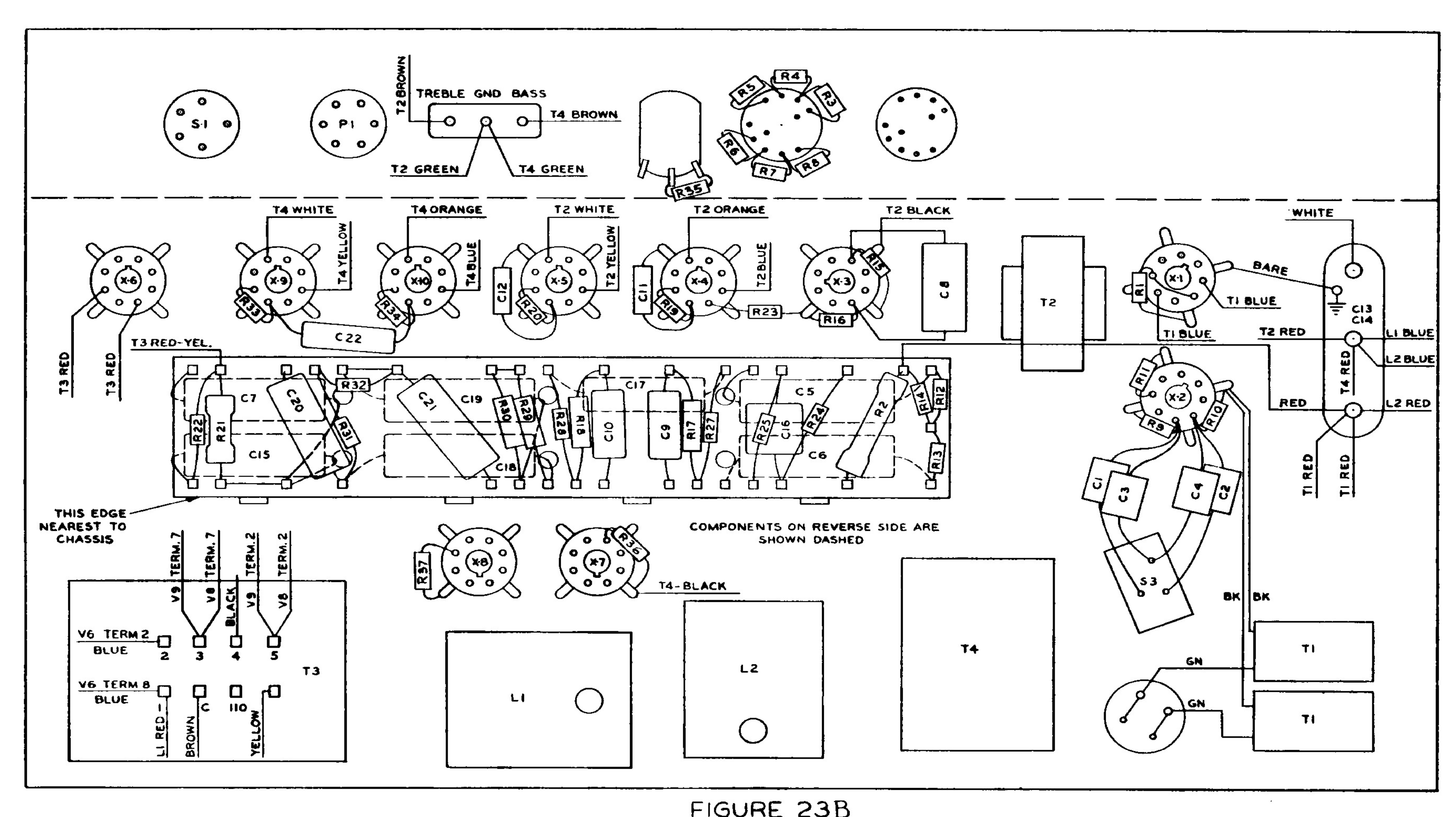


FIGURE 23B
INSIDE VIEW OF AO-15 AMPLIFIER
SHOWING LOCATION OF COMPONENTS

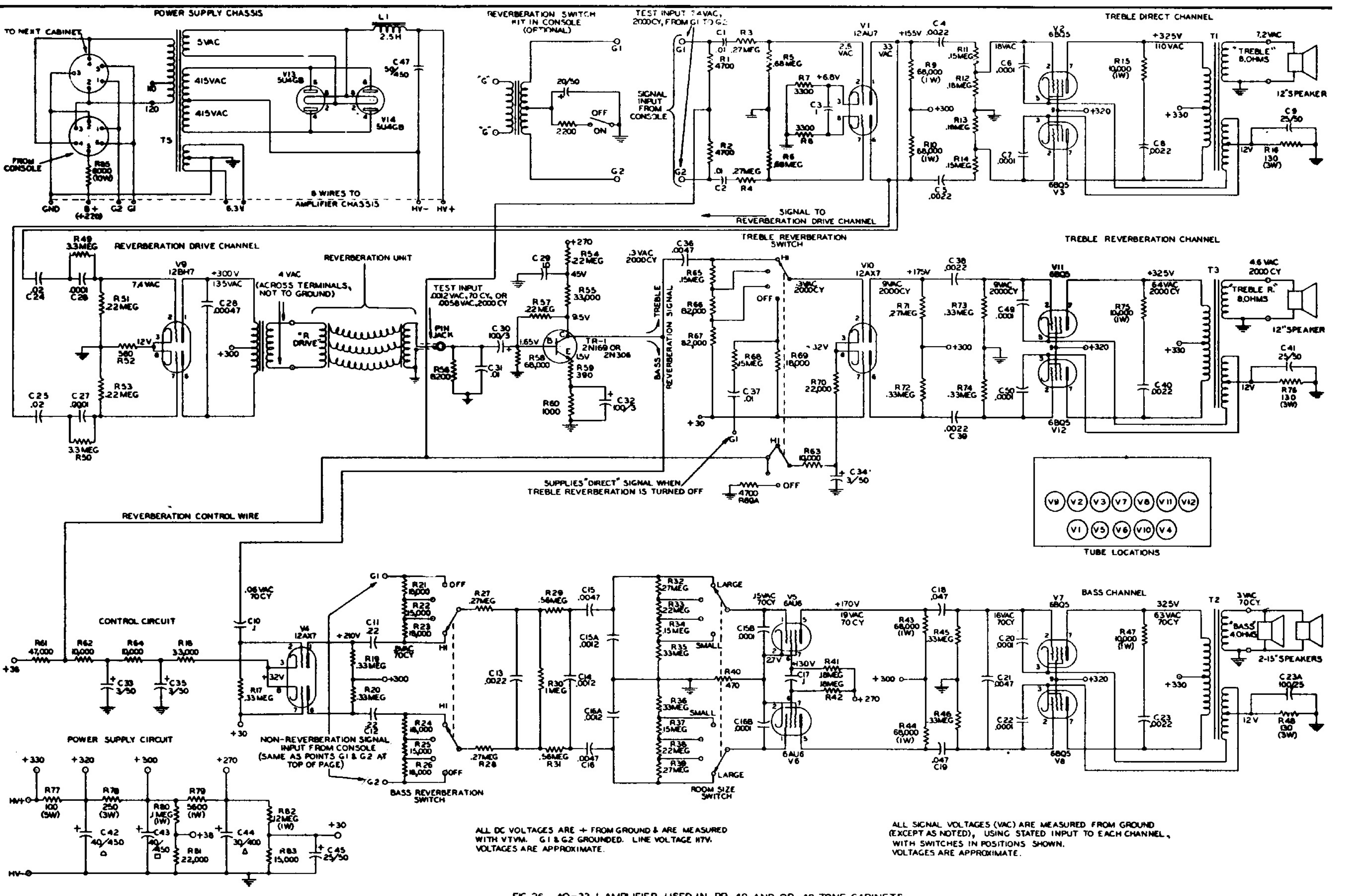
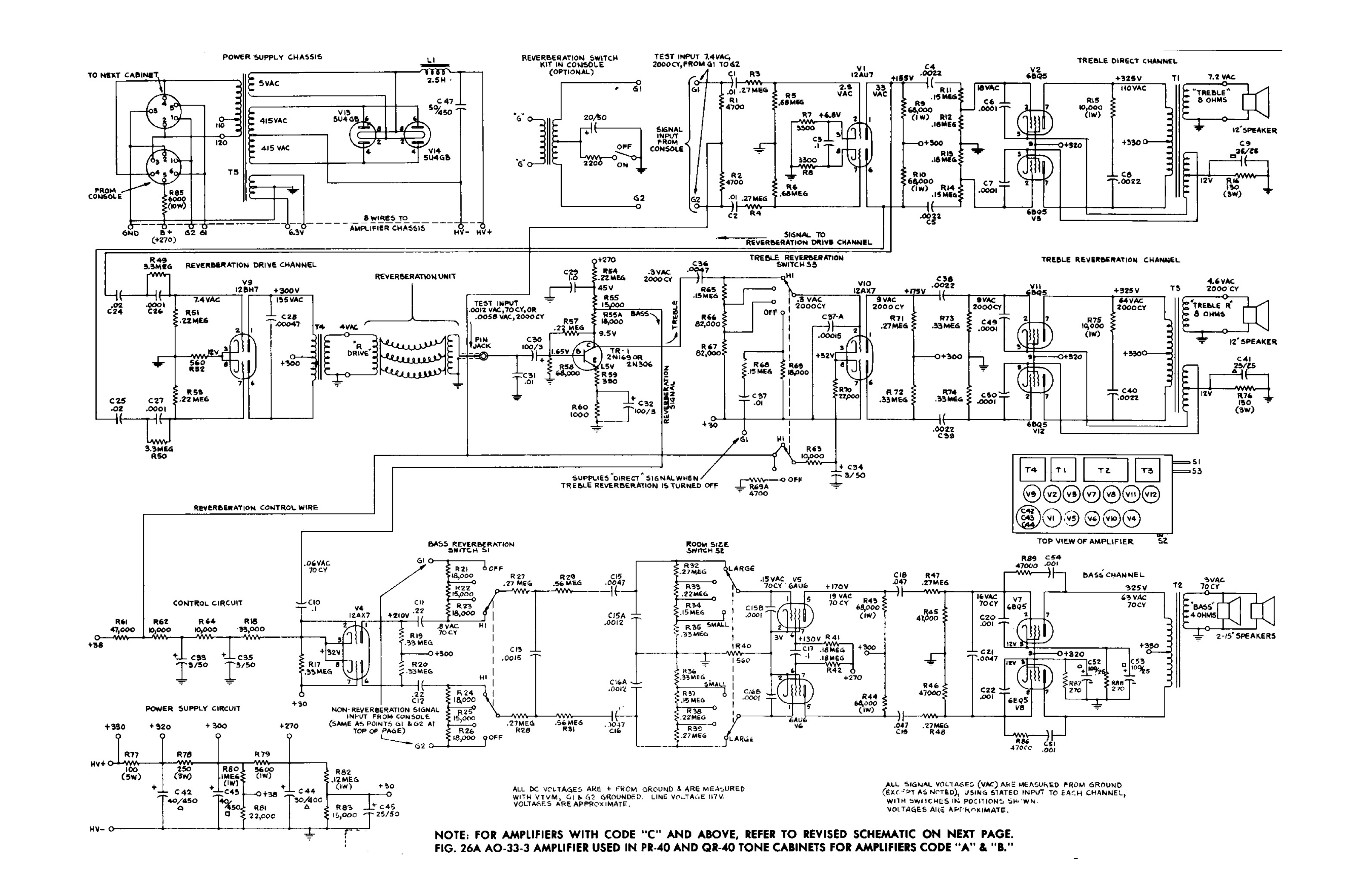


FIG. 26 AO-33-1 AMPLIFIER USED IN PR-40 AND QR-40 TONE CABINETS



ALL DC VOLTAGES ARE + FROM GROUND & ARE MEASURED WITH VTVM, G1 & G2 GROUNDED. LINE VOLTAGE 117V. VOLTAGES ARE APPROXIMATE.

ALL SIGNAL VOLTAGES (VAC) ARE MEASURED FROM GROUND (EXCEPT AS NOTED), USING STATED INPUT TO EACH CHANNEL, WITH SWITCHES IN POSITIONS SHOWN. VOLTAGES ARE APPROXIMATE.

NOTE: FOR AMPLIFIERS WITH CODE "C" AND ABOVE, REFER TO REVISED SCHEMATIC ON NEXT PAGE.

FIG. 26A AO-33-3 AMPLIFIER USED IN PR-40 AND QR-40 TONE CABINETS FOR AMPLIFIERS CODE "A" & "B."

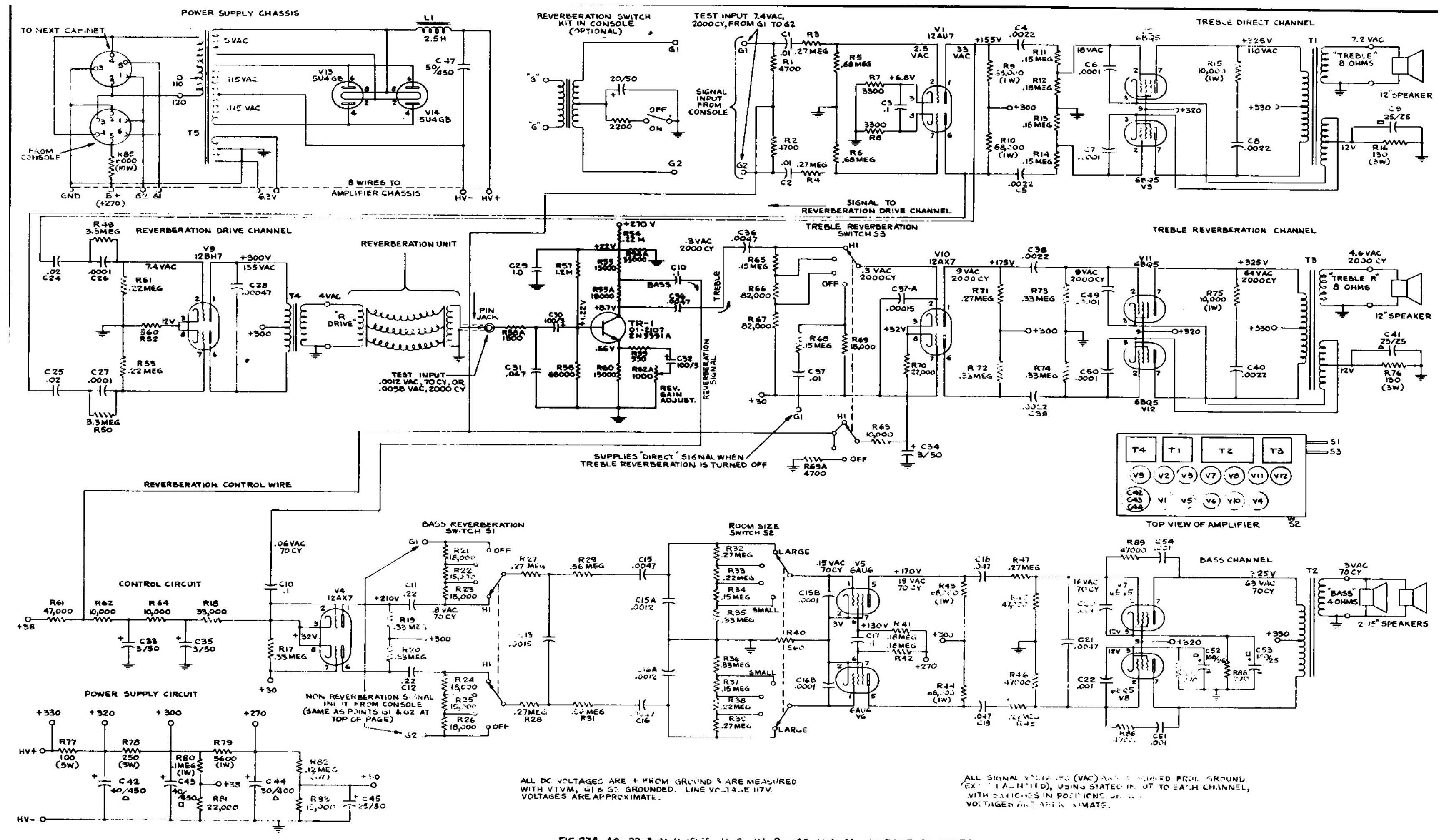


FIG 27A AO-33-3 AMPLIFIER USED IN PR-40 AND QR-40 TONE CABINETS

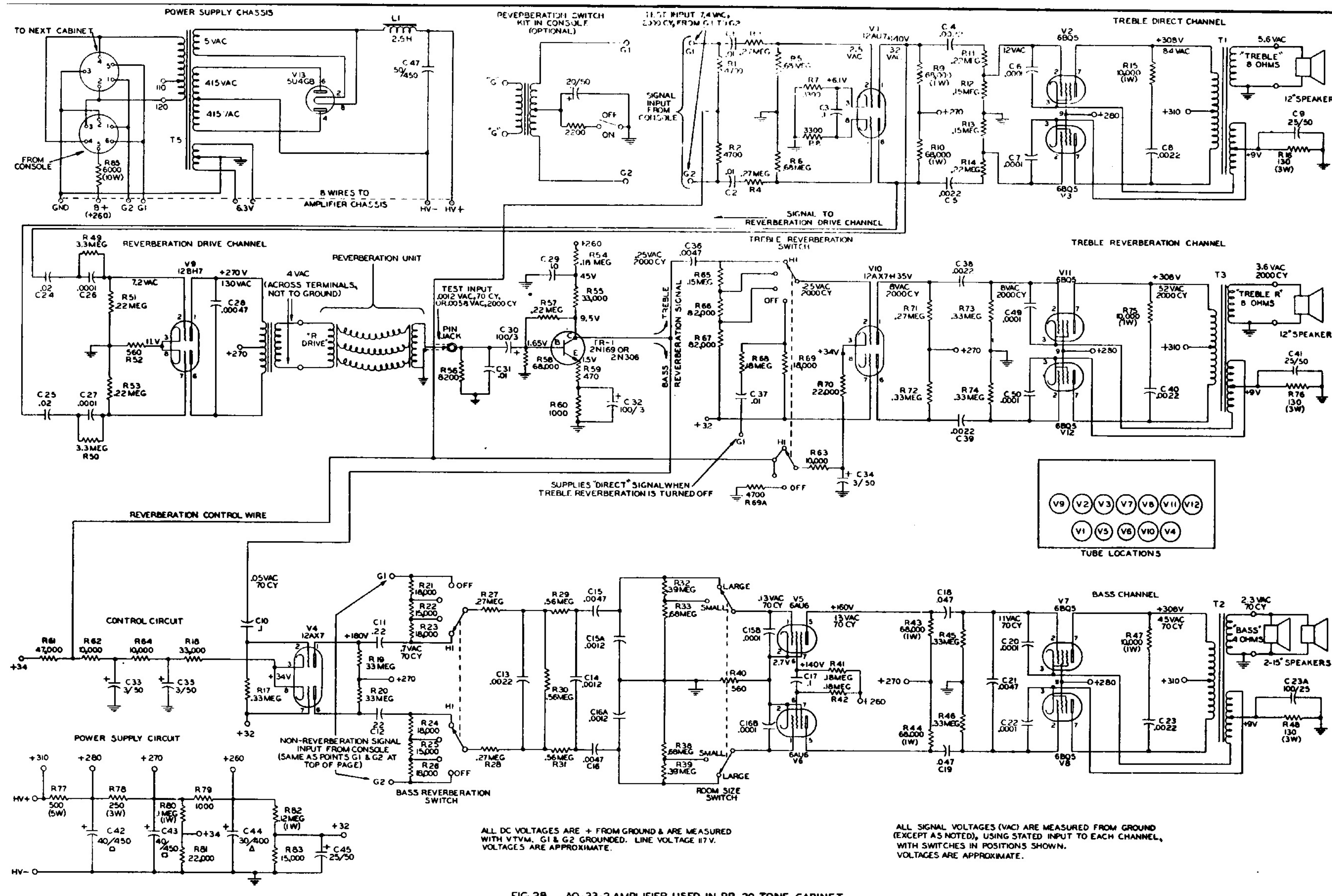


FIG.28 AO-33-2 AMPLIFIER USED IN PR-20 TONE CABINET

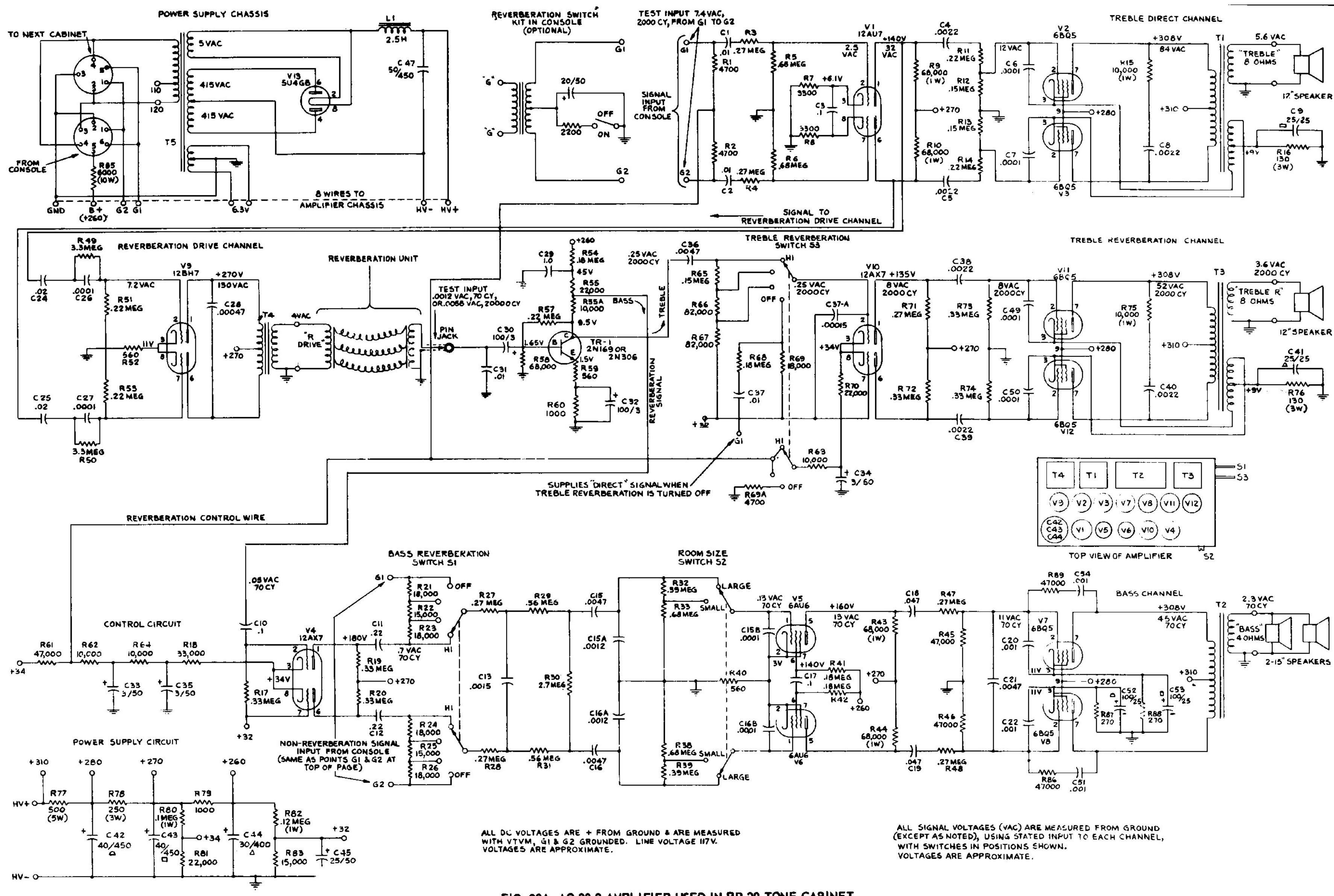


FIG. 28A AO-33-2 AMPLIFIER USED IN PR-20 TONE CABINET

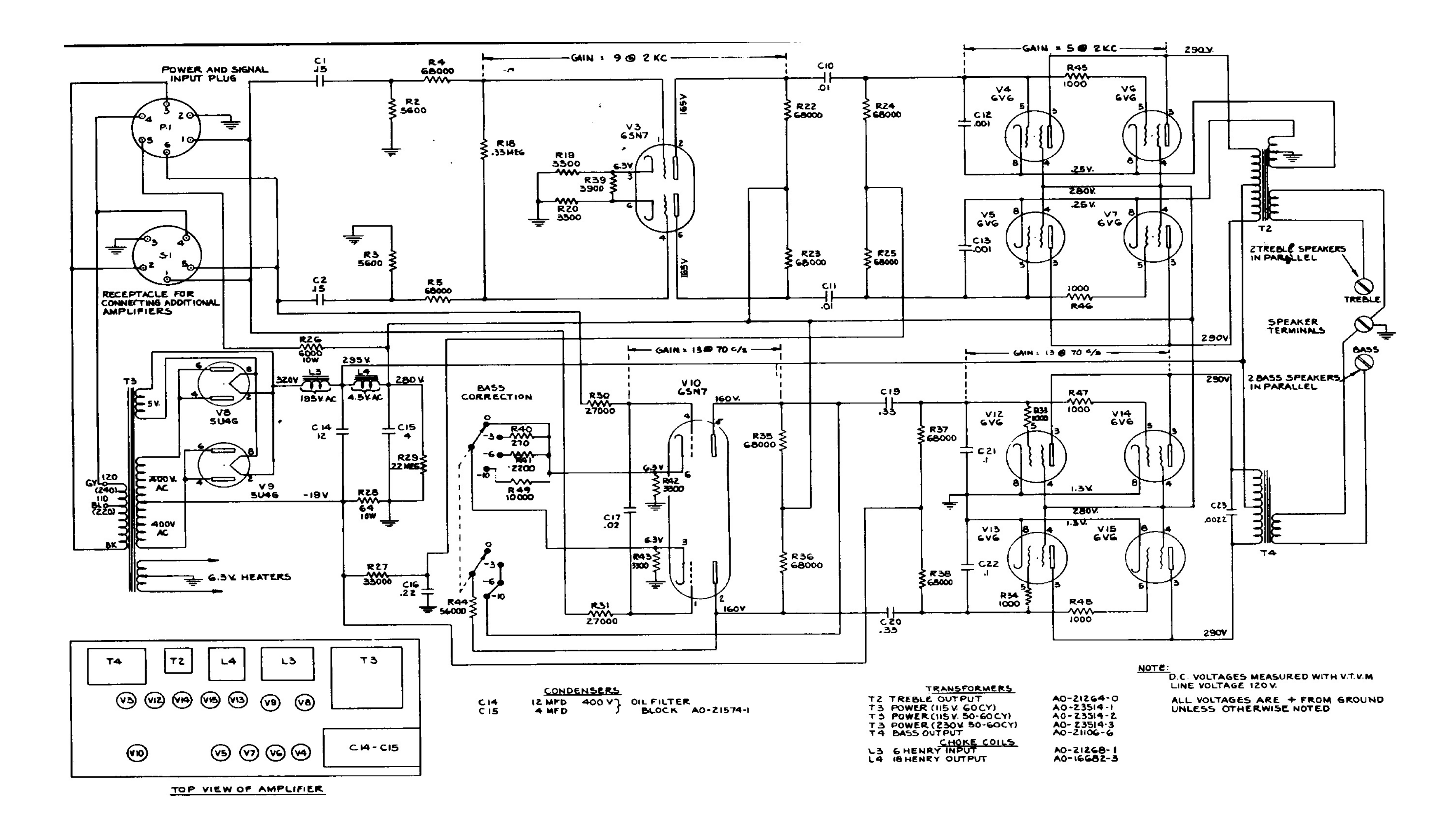


Fig. 29 — AO-40 AMPLIFIER USED IN P40 AND Q40 TONE CABINETS

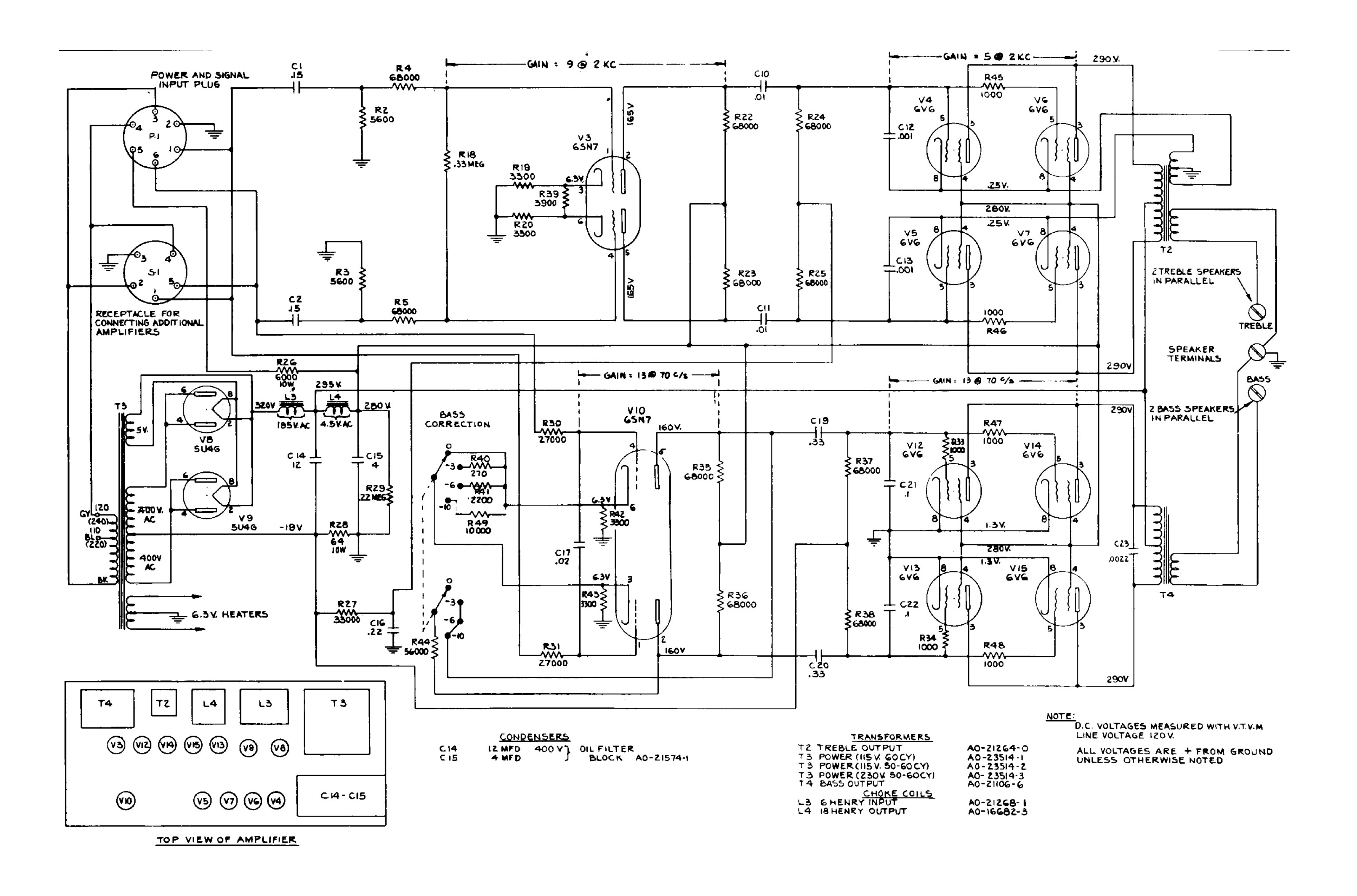
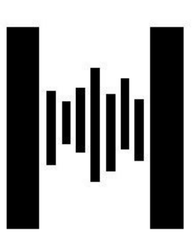


FIG. 30 – A0-40 AMPLIFIER USED IN P40 AND Q40 TONE CABINETS

THE HAMMOND ORGAN

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TROUBLESHOOTING



HAMMOND ORGAN COMPANY
North Western Avenue - Chicago
Diversey Ave - Chicago
North 25th Avenue - Melrose Park
Copenhagen Court - Franklin Park
Illinois
USA

THE FOLLOWING INFORMATION PERTAINS SPECIFICALLY TO THE MODELS B-3 AND C-3. HOWEVER DUE TO THE SIMILARITY OF THE CONSOLES, MUCH OF THE INFORMATION CAN BE APPLIED TO ALL OTHER MODELS.

SECTION 1 of the original manual was a General Description overview already covered in the 2016 edition and has been intentionally omitted.

PRE-REPAIR PROCEDURES

2-1. POWER REQUIREMENTS.

2-2. POWER SOURCE. For operation, operational tests, and repair procedures, the Model C-3 Hammond Organ requires connection to a standard 60-cycle, 117-volt (or 50 cycle, 234-volt) power source.

2-3. INSPECTING, STRIPPING, CLEANING, AND LUBRICATING.

2-4. OVERALL INSPECTION.

2-5. Rotate all controls and operate all switches. Pull out all drawbars. Operation should be smooth. Toggles should snap firmly into position. Depress the playing keys; check for proper tension in each case and for cracks and chips. Check the operation of the locking and trip mechanism by striking each preset and adjust key in turn. Be sure that the cancel key releases the associated preset or adjust key on each manual.

2-6. Check the mounting of the reverberation spring system assembly in the tone cabinet. Determine that the locking lever is in its unlocked position; if it is not, unlock as indicated on instruction card on tone cabinet.

2-7. Insert all connector plugs into their receptacles. Plug should seat firmly and must make good contact. Inspect all connector plug for loose prongs or pins. Examine all cords and cables for frayed insulation and defective wiring. Check for kinks, bends, or twists.

2-8. Inspect all parts and wiring for rust, corrosion, loose connections, frayed or burned insulation, loose mounting screws and bolts, and burned resistors and coils. Check and tighten all mechanical fasteners, such as screws and bolts. Make a thorough inspection of all tube sockets for broken contacts. Examine all switches for loose or bent contacts and for broken insulation. Inspect spring for proper tension. Be sure that each end of each spring is properly attached to the associated parts. Inspect for any broken parts, evidence of excessive heating and overloading, as indicated by burned resist on or melted wax. Look and smell for these latter troubles.

2-9. Examine all terminal strips, boards, and panels for defective wiring, broken lugs, loose contacts, and signs of burning. Be sure that all screws on the preset panel are securely tightened in position and that all leads are held firmly in place.

2-10. Push down and raise the swell pedal and note the action of the crank and hinge assembly. Tighten mounting screws where necessary.

2-11. Check the speaker cones for defects. Check the speaker mounting bolts for tightness.

2-12. Inspect all pedals on the pedal clavier for cracks or breaks and for proper tension. (Each pedal should just come up when a 3-pound weight is placed directly behind the pedal sharp cap.) Be sure that the flat spring pushers at the ends of the levers are firmly mounted and are properly seated in place over the pedal switches*. Determine that the felt pad extending over all the plungers is in place and not worn. Adjustable tension springs are made accessible by removing the cover board from the rear of the pedal clavier. If pedals become loose and rebound when played rapidly, increase the tension by tightening the adjustment screws*. (* = Figure 14, Section 8)

2-13. Check the generator anchoring fittings. They should be unscrewed so that the generator floats freely. Be sure that all suspension springs for the generators are connected in position at both ends and are properly positioned.

2-14. Be sure that the console is located on a rigid level surface, so that the generator mounting mechanism, anchored to the generator frame, is free to move in any direction without coming in contact with the wooden shelf of the console bottom.

2-15. Be sure that the tone cabinet is located with the open back placed 2 inches or more from the wall or other obstruction. Be sure that adequate ventilation has been provided.

2-16. Check all tubes for cracks in glass or base, and for bent or broken prongs. Inspect for firm mounting of the tubes in their sockets. Test tubes for low emission, leakage, and short circuits. Test all tubes at least semi-annually and replace them at least every 18 months. Inspect pins and bases for accumulations of foreign matter.

2-17. As the Model C-3 Hammond Organ is used in chapels and auditoriums, it is unlikely that inspection will find the organ deteriorated beyond repair, except where it has been subjected to fire or explosion.

2-18. REMOVAL AND REPLACEMENT OF PLUCK-OUT PARTS.

2-19. VACUUM TUBES. The following instructions apply when it is necessary to remove and replace vacuum tubes.

a. Table I lists the tube complement of the Model C-3 Hammond Organ and Model PR-40 Tone Cabinet.

b. Never remove tubes from the amplifiers when the organ is turned on. Avoid working on the tubes immediately after shut-down; severe burns may result from contact with the envelopes of hot tubes. Never jar a warm tube.

c. When replacing a defective tube, do not jiggle the tube from side to side in its socket. Movement of the tube weakens the pins in the base and unnecessarily spreads the contacts in the socket. Replace the defective tube; be sure that the replacement is pressed down firmly in its socket.

TABLE I

Unit	Tube	Quantity	Unit	Tube	Quantity
Console Preamplifier	6AU6	2	Power Amplifier (in PR-40 Tone Cabinet)	5U4GB	2
	6C4	2		6AU6	2
	6X4	1		6BQ5	6
	12AU7	1		12AU7	1
	12AX7	1		12AX7	2
	12BH7	1		12BH7	1

2-20. PEDALCLAVIER. The following instructions apply when necessary to remove and replace the pedalclavier.

a. Remove the bench positioned over the pedal clavier.

b. Lift the console end of the pedal clavier and pull slightly up and out.

c. To replace the pedal clavier, place it in position, lifting slightly at the front, and slide it under the console until it locks in place. Place the bench in its proper position over the foot pedals.

2-21. CORDS AND CABLES. Disconnect cords and cables by firmly grasping the connector plug and pulling it.

2-22. CLEANING.

2-23. The following materials are required to perform cleaning operations on the Model C-3 Hammond Organ:

a. Clean cloth.

b. Dry-cleaning solvent.

c. Paint brush with camel's hair bristles.

d. lint-free, bleached cloth

e. Compressed air.

f. Crocus cloth.

2-24. Remove corrosion, rust, or dirt. Blowout dirt and dust from the interior of the console and the tone cabinet. If an air hose is used, be sure that any water which may have condensed in it is blown out before applying the air stream to the equipment. When using compressed air to remove dirt, be careful not to disturb the wiring. Scrape off tar or other adhering foreign matter; touch up with paint or lacquer if necessary.

2-25. Clean the vacuum tube sockets and pin receptacles with solvent and a camel's hair brush. If necessary, clean pins with crocus cloth.

2-26. Clean all wooden parts and playing keys with a clean, lint-free cloth. Accumulations of dirt and dust in the key contacts may be removed by adjusting the bus bar shifters. (See paragraphs 4-9 to 4-13 inclusive.) No disassembly is required.

2-27. LUBRICATION

2-28. APPROVED LUBRICANTS. The following listed lubricating material is required to service the Model C-3 Hammond Organ: Spec MIL-L-644

2-29. CONSOLE. Some moving parts receive lubrication by capillary action via cotton threads connected to the central oil trough. Oil is fed to this trough from two oil cups (See picture on page 1 of Main Generator section). To pin access to these oil cups, remove the rear dust panel by unscrewing the two thumb screw bolts. Every year fill the oil cups three-quarters full with oil, Spec MIL-L-644. (The oil level will slowly drop; however, do not continue adding oil.)

2-30. INSPECTING AND TESTING REMOVED PARTS.

2-31. VACUUM TUBES.
2-32. INSPECTING. Check each tube for tight mounting in its socket. Inspect visually for mechanical and other obvious defects. Discard defective tubes. Be certain that each tube is of the type specified.

NOTE

Return each tube, if found to be good, to the socket from which it was removed. Distortion will result if replaced tubes are mismatched.

2-33. TESTING. Use tube checker in accordance with the instructions furnished. Do not neglect the short circuiting test.

2-34. CABLES AND CONNECTORS.

2-35. INSPECTING. Inspect cables for cracked, frayed, or deteriorated insulation at the connecting or supporting points. Inspect the cables or connectors for improper placement which puts them under strain. Watch for kinks and improper supports. Inspect all connectors for dirt, corrosion, and damaged or loose contacts or terminals. To prevent possible short circuits, be sure no corrosion or dirt remains between the contacts.

2-36. TESTING. Use an ohmmeter and make continuity checks on the cables. Test for grounding and for shorting between points; if defects are discovered in connectors, replace the connectors. Test the voice coils. Reading of approximately 8 ohms should be obtained.

TROUBLE LOCATION

3-1. TROUBLESHOOTING.

3-2. GENERAL. When troubleshooting, use all of the aids included in this manual: block diagrams (see General Descriptions), overall schematics, amplifier schematics (see Wiring and Schematic Diagrams), illustrations of components (throughout manual), and the trouble shooting chart (reference paragraph 3-28). Before starting an elaborate test procedure, make a thorough visual inspection to locate the fault. Check for defective wiring, drops of solder, faulty connections, open resistors and capacitors, jammed tone wheels, etc.

3-3. TUBE TESTING. When the trouble is traced to a specific stage, test tubes in that stage. If tubes are satisfactory, make a point-to-point voltage check in accordance with paragraph 3-4.

3-4. VOLTAGE AND RESISTANCE MEASUREMENTS. Make voltage and resistance measurements on the individual components of the stage (as shown in specific console schematic). Make all capacitor checks with capacitor analyzer if available. Always disconnect capacitors before making tests; otherwise the readings will be affected by a possible shunt circuit. Replace any capacitor which shows a deviation of 20 percent or more.

3-5. RESISTORS. Resistors used in Hammond Organs are marked with the standard EIA (Electronic Industries Association) color code, as shown in Table II. In this code, the body color or first color ring (starting from the outside edge) indicates the first digit of the resistor value. The second ring denotes the second digit, and the third ring represents the number of zeros after the second digit. Thus a resistor marked with brown, green; and yellow rings (in that order) would have a value of 150,000 ohms. Gold and silver rings represent percentage tolerance, gold indicating 5 percent tolerance and silver indicating 10 percent tolerance. Replace resistors differing by as much as 30% from their rated values.

TABLE II - RESISTOR COLOR CODE

0-Black	4-Yellow	
1-Brown	5-Green	
2-Red	6-Blue	8-Gray
3-Orange	7-Violet	9-White

3-6. COIL MEASUREMENTS. For the DC (direct current) resistance value of chokes and audio transformers, refer to the appropriate circuit diagram. An open winding in the choke or transformer will be indicated by no ohmmeter indication. Check the power and filament transformers by comparing their measured voltage with the voltages given in the circuit diagram. All voltage values are given for a 117- volt (or 234-volt) AC input. If the input voltage varies, a corresponding change will be noted.

3-7. SECTIONALIZING TROUBLE

3-8. AMPLIFICATION SYSTEM TROUBLES.

3-9. Such troubles as loss of volume, poor quality, excessive hum, noisy operation, or no signal are usually traceable to the amplification system. For example, if distortion is noted in the loud speakers, connect a headset across terminals marked G - G on the console preamplifier. If the quality is good on the headset, the cause of the distortion will be found in the amplification system following the console preamplifier. Should distortion occur at the preamplifier terminals, replace all tubes. Should distortion in the console preamplifier continue, test each preamplifier stage individually with the headset. When the defective stage is located, test each capacitor and resistor for deterioration.

CAUTION: Insert an 0.1 mfd, 400 volt DC capacitor in series with the headset to prevent DC voltage from damaging it.

3-10. HUM.

3-11. Hum in the loud speakers may indicate trouble in the reverberation spring system assembly. (Reference paragraph 3-28.) If a sustained hum or howl is heard, starting only when a low note is played at high volume, check for the following:

a. Microphonic tubes in the amplifier. Replace all tubes if necessary.
b. Improper grounding of all plug connections to and from the amplifier.
c. Defective bypass capacitors in the reverberation portion of the amplifier.
d. Locked spring system.
e. Improper mounting of the reverberation unit.
f. Presence of undesirable magnetic fields, such as motors, generators, supply transformers, and other equipment generating heavy magnetic field patterns.

3-12. LOCATING AND CORRECTING DEFECTIVE INDIVIDUAL TONES.

3-13. Silent or weak individual tones are usually caused by defects in the circuit ahead of the amplification system. Such defects can be traced to the tone generator and filter circuits, key circuits and board connections, and signal wiring between the manual chassis, generators, and pedal switch. Trouble occurring over the full range of tones and present at the input to the console preamplifier can usually be traced to a defect in the mixing transformer or associated circuitry.

3-14. LOCATING DEFECTIVE TONES.

3-15. Depress preset key A# on the upper manual. (See figure 1 in Manuals, Pedals, etc.)

3-16. Pull out the first (No.1) brown drawbar only in the first set of drawbars in the left-hand group.

3-17. Start with the first key, C, (frequency No. 13) of the upper manual and strike each higher note on this manual in succession. The last note at the right end of the keyboard is C (frequency No. 61). Note the frequency numbers of all weak or dead notes. Figures 4 (p. 5) & 13 (p.15) in Manuals, Pedals, etc. indicates all key numbers and notes and the corresponding frequency numbers for each drawbar.

3-18. Return the first brown drawbar to its original position and then pull out the last white drawbar only, in the same draw bar set. (Reference paragraph 3-16.) Start at the second C note (frequency No. 61), and strike each higher note on the upper manual in succession until the second F# note from the top of the keyboard is reached. This F# note corresponds to frequency #91, the highest frequency produced by the generator. Note the frequency number of all weak or dead notes.

3-19. Repeat the procedures of paragraphs 3-15 to 3-18 inclusive, on the lower manual. Use the No. 1 brown and No. 9 white drawbars in the first set of drawbars in the right-hand drawbar group.

3-20. If all notes are uniform in intensity or change evenly from note to note, the tone generators are operating normally. However, if notes are weak or absent, proceed as directed in paragraph 3-21.

3-21. CORRECTION.

3-22. A single dead or weak note which occurs on one manual but not on the other, may be caused by a fault in the key contacts. To correct this fault, adjust the bus bar shifters associated with the pedal switch and both manuals as directed in paragraphs 4-9 to 4-13 inclusive.

3-23. A single weak or dead note occurring at the same point on both manuals may be caused by a defective generator, a broken wire, or a poorly soldered joint on the terminal strip. Test the generator for output by fastening a short length of wire to the 6th busbar, from the bottom, on the preset panel; then touch the other end of the wire to each lug on the generator terminal strip. If all notes sound. the cable wire or soldered joint is at fault and must be repaired. If no generator output exists. either the filter circuit or the magnet pickup coil may be defective. or the tone wheel is not rotating.

3-24. Figures 5 & 6 in the Main Generator section illustrates the position of each filter reactor and capacitor on the generator cover. Fasten a short piece of wire to the 6th busbar from the bottom, on the preset panel, and test each terminal of the filter. (Reference paragraph 3-23.) If the filter is at fault, replace the defective component as described in paragraphs 5-86 and 5-87.

3-25. If there is no signal across the magnet pickup coil terminals, even with the coil disconnected, either the coil is defective or the associated tone wheel is not turning. Check the pickup coil by unsoldering its lead and, with a short piece of wire, connect the lead to the preset panel. (Reference paragraph 5-6.)

3-26. When there are two dead notes on each manual, determine which frequencies are at fault, as described in paragraphs 3-14 to 3-20 inclusive. Figure 4 in the Main Generator section illustrates the exact location of the magnet associated with each frequency; the dotted lines connecting the frequency numbers indicate that they are generated by two tone wheels on the same shaft and in the same compartment. (It should be noted that with few exceptions, tone wheels on the same shaft differ in frequency numbers by 48.) On frequency numbers 37,38, 39,40, and 41, only a single active tone wheel is on each shaft. If the 2 magnets associated with the dead notes are together, 1 tone wheel is probably jammed against the magnet tip. To correct this condition, proceed as follows:

a. Loosen the set screw on the magnet to be adjusted, then move the magnet back slightly. Do not twist it.

b. Strike the proper playing key. The note should now sound.

c. To make the final adjustment, strike and hold down the playing key for the note being adjusted. Then tighten the magnet slightly in position and tap it gently until it moves close to the tone wheel to bring the intensity up to the intensity of the adjacent notes. Tighten the set screw so that the magnet is held firmly in position.

d. Do not remove main tone generator assembly from the console unless absolutely necessary. Should this be necessary, proceed as directed in paragraphs 5-63 to 5-71 inclusive.

3-27. TROUBLESHOOTING CHART.

3-28. The following troubleshooting chart contains general information to aid in the location of trouble. When the trouble stage is sectionalized, refer to Section V for detailed aid in identifying the trouble with a particular part.

SYMPTOM	PROBABLE CAUSE OR REMEDIAL ACTION
1. No Signal	Check the source of supply; a 117-volt, 60-cycle (or 234-volt, 50-cycle), AC power source is required. Check the power and connecting cables for secure mounting, good contact, and broken pins. Check the power supply voltage in the tone cabinet. Check all vacuum tubes. Connect output meter across the console preamplifier output terminals. If no output is obtained, conduct a point-to-point voltage test on the defective unit. Check the signal input to the power amplifier and compare the reading with the console preamplifier output reading on the output meter. These should be identical. If no output reading is obtained, conduct a point-to-point voltage test on the defective unit. Check the power amplifier output. If no output reading is obtained, conduct a point-to-point voltage test.
2. Loss of Volume, All Notes	Low voltage, source of supply. Check the console preamplifier output voltages. Check the power amplifier output voltages. Check all vacuum tubes. (Reference paragraph 3-3.) Low voltage from power supply. Conduct a point-to-point voltage test and check for defective components.
3. Loss of Volume, Single Note	Dust or accumulation of dirt on contact; make adjustment. (Reference paragraphs 4-9 to 4-13 inclusive.) Poorly soldered connection or high resistance contact in console wiring. Trace the signal intensity throughout the circuit by means of high-impedance headset (circuit to ground). As an alternative method, attach one end of an insulated test lead (48 inches long) to 6th bus bar from bottom, on preset panel, and use other lead end to trace the signal intensity throughout the manual wiring.

4. Poor Quality	Use low volume, and check the console pre-amplifier output with high impedance headset. Check all vacuum tubes. Make a point-to-point voltage test. (Reference paragraph 3-4.) Check individual components for defects, especially audio bypass capacitors and frequency filters. Be sure that the voice coils are not rubbing against pole pieces.
5. Excessive Hum	Check all connecting plugs for loose connections. Check wiring connections in cable plugs. Check for defective filter capacitors in power amplifier. Check all vacuum tubes. Replace if necessary. Remove all inductive electric or electronic equipment in the vicinity of the console cabinet. Check all bypass capacitors, particularly on cathode-to-ground circuits. Check ground connection from generator to two halves of lowest preset panel bar.
6. Rattle or Intermittent Operations	Loose connections between cable connectors. Loose cable connections in connector plugs. Damaged speaker cone. Voice coil rubbing on pole piece. Defective vacuum tube. Check lubrication. Check the individual felt pad used on each manual key or bass pedal to absorb the striking sound. Check for intermittent resistors or capacitors by lightly tapping suspected components. Check the suspension of the reverberation spring system assembly. Adjust the bus bar shifters. (Reference paragraphs 4-9 to 4-13 inclusive.)
7. Miscellaneous	
a. Howl, or unwanted sustaining of tone	Check reverberation unit locking lever. (Reference paragraph 2-6.)
b. Bass pedals release sluggishly	Check and increase tension of leaf springs at end of bass pedals.
c. Preset keys fail to release properly	Replace leaf bracket and associated leaf spring; replace key if necessary. Reference paragraphs 5-73 to 5-75 inclusive

ALIGNMENT PROCEDURES

4-1. PRESET PANEL TONE SELECTION.

4-2. The preset keys shown in figure 1-2 are used to select the ready-mixed tone colors. Nine color-coded wires from each preset key are fastened to the busbars of the preset panel by slotted screws. Each group of nine color-coded wires is fed through individual holes below the preset panel. The color coding of each group is identical to the color coding of the nine wires from the drawbars (above the preset panel). The drawbars can be withdrawn to numbered stops. The frequency relationship of the wire color coding is indicated below. Note that the color sequence is the same as the EIA color code for resistors.

Brown .... Sub-fundamental
Red .... Sub-3rd harmonic
Orange ....Fundamental
Yellow ....2nd harmonic
Green .... 3rd harmonic
Blue ....4th harmonic
Violet ....5th harmonic
Gray .... 6th harmonic
White .... 8th harmonic

4-3. The tone color or quality of any note, played on either the upper or lower manual, is determined by the intensity of the harmonics in relation to the fundamental note as selected either by the preset key or drawbars. The numbers of the preset panel and drawbars indicate a progressive increase in intensity, starting from 0 (drawbar fully pushed in) to 8 inclusive. Any tone color may be identified by a number containing 9 digits, each digit representative of the intensity of the fundamental tone or 1 harmonic as selected on the drawbars or preset panel.

4-4. The Hammond Organ has its preset panel arranged to make available to the organist tonalities similar to those ordinarily found in the small church or chapel pipe organ, as well as tones for religious services and congregational singing, without the use of the adjustable drawbars. Table IV illustrates the approved preset panel arrangement for chapel organs. Remove the rear panel of the console, examine, and check the preset panel to determine that the preset panel corresponds exactly to Table IV. Change the position of any lead by loosening the slotted screw which secures it in place, removing the lead, and then securing it in correct position by means of the slotted screw provided. Refer to console wiring diagrams.

TABLE IV - HAMMOND ORGAN PRESET DATA

UPPER MANUAL				LOWER MANUAL			
Preset Keys	Equivalent Drawbar Setting	Tone Quality	Value	Preset Keys	Equivalent Drawbar Setting	Tone Quality	Value
C		Cancel		C		Cancel	
C#	00 5320 000	Stopped Flute	pp	C#	00 4545 440	Cello	mp
D	00 4432 000	Dulciana	ppp	D	00 4423 220	Flute & String	mp
D#	00 8740 000	French Horn	mf	D#	00 7373 430	Clarinet	mf
E	00 4544 222	Salicional	pp	E	00 4544 220	Diapason, Gamba and Flute	mf
F	00 5403 000	Flute 8' & 4'	p	F	00 6644 322	Great, no reeds	f
F#	00 4675 300	Oboe Horn	mf	F#	00 5642 200	Open Diapason	f
G	00 5644 320	Swell Diapason	mf	G	00 6845 433	Full Great	ff
G#	00 6876 540	Trumpet	f	G#	00 8030 000	Tibia Clausa	f
A	32 7645 222	Full Swell	ff	A	42 7866 244	Full Great with 16'	fff
A#	Adjust harmonic drawbars for 1st Group, Upper Manual			A#	Adjust harmonic drawbars for 1st Group, Lower Manual		
B	Adjust harmonic drawbars for 2nd Group, Upper Manual			B	Adjust harmonic drawbars for 2nd Group, Lower Manual		

4-5. ALIGNMENT OF COIL ASSEMBLIES.

4-6. Each magnet and coil for each tone wheel is mounted in the tone generator as a single assembly. (See figures 2 & 3 in Main Generator section.) To locate and determine which coil assemblies require alignment, proceed as follows:

a. Remove the console rear panel.

b. Connect an output voltmeter (1,000 ohms per volt scale) across the two terminals marked G.

c. Set both the vibrato controls, and all percussion tablets, to their OFF positions.

d. Depress the swell pedal to the position of maximum volume.

e. Disconnect tone cabinet from console.

f. Connect one end of a test lead to the 5th preset panel busbar, from the bottom.

g. Place the organ in operation.

h. Check the AC input voltage at the console preamplifier terminal board; the voltage should be 117 volts or 234 volts. Any variation of input supply voltage will give a corresponding increase or decrease of reading. as shown in Table V.

i. Check the output voltage of each coil assembly by touching the prod end of the test lead to each terminal in turn on the main generator terminal board. The frequency numbers are not indicated. For location of exact frequency, see figure 5 or 6 in the Main Generator section.

j. Compare each voltage obtained with the appropriate voltage listed in Table V. Do not try to adjust to these voltages unless the values deviate more than 30 percent.

4-7. If it is ascertained that the coil assemblies require alignment, proceed as follows:

a. Disconnect the generator assembly only when absolutely necessary. Make adjustments from the rear whenever possible. Do not remove the cover as this necessitates unsoldering and resoldering 91 leads, in addition to realigning all coil assemblies.

b. Refer to figure 4 in Main Generator section and determine which coil assemblies require alignment.

c. Loosen the set screw which holds the coil assembly in position.

d. Compare the intensity of the note associated with the aligned coil with the intensity of adjacent notes.

e. Tap the coil assembly gently until it moves close enough to the tone wheel to bring the intensity up to the intensity of the adjacent notes; pull coil assembly back if necessary. Do not turn magnet during this operation.

f. Tighten the set screw.

CAUTION:

These coil assemblies are locked into position at the factory and seldom require adjustment. Do not pull back with a twisting motion, as damage will result.

TABLE V
GENERATOR OUTPUT VOLTAGES

Freq. No.	Output (V)	Freq. No.	Output (V)	Freq. No.	Output (V)	Freq. No.	Output (V)
1	9.8	23	15	45	2.7	67	1.2
2	11	24	14	46	2	68	1.6
3	11.5	25	11.5	47	2.5	69	2
4	12	26	12	48	2	70	1.6
5	13	27	10	49	2.25	71	2
6	14	28	11	50	3	72	1.4
7	15	29	10	51	1.5	73	1.4
8	15	30	10	52	2	74	1.2
9	16	31	11	53	1.8	75	1
10	15	32	8.5	54	1.8	76	1.2
11	16	33	10	55	1.8	77	1
12	13	34	9	56	1.8	78	1.2
13	14.5	35	10	57	2	79	0.8
14	15	36	8	58	1	80	0.6
15	14	37	9.5	59	1.8	81	0.7
16	15	38	10	60	1.5	82	0.4
17	14	39	9	61	3	83	0.6
18	15	40	10	62	3	84	0.5
19	15	41	8	63	2	85	0.7
20	16	42	9	64	2.5	86	0.5
21	15	43	9	65	2.2	87	0.3
22	13	44	2.5	66	3	88	0.4
						89	0.2
						90	0.5
						91	0.25

4-8. ADJUSTMENT OF PERCUSSION CUTOFF CONTROL. This control, located in the preamplifier (See figure 1-7) should be readjusted whenever control tube V7 is replaced. Set expression pedal wide open, both volume tablets to Normal, percussion tablet ON , and harmonic selector in either position. Play any key in upper half of upper manual, hold it down at least 5 seconds, and then adjust percussion cut-off control exactly to the point where the signal becomes inaudible.

4-9. ADJUSTMENT OF INTERMITIENT OR NON-OPERATING KEYS.

4-10. Scratchy, noisy, or silent keys may result from accumulations of dust which lodge in the contacts. To correct this condition, strike the key 15 to 20 times in a rapid staccato manner to dislodge the dust particles and to clear the contacts.

4-11. If this procedure does not dislodge the dust particles, adjust the busbar shifters. (See Rear View of consoles at end of General Descriptions, figure 21 in Manuals, Pedals, etc., and figures 4-2 & 4-3 below) Busbar shifter A, located behind the matching transformer, adjusts the busbars associated with the keys of the upper manual; busbar shifter B adjusts the busbars associated with the keys of the lower manual; busbar shifter C adjusts the busbars associated with the pedal keyboard.

4-12. Turn the proper busbar shifter about two turns in either direction. This operation permits the key contacts to strike a new position on the busbar and should free all contacts of accumulated dust particles.

4-13. If, in extremely stubborn cases, the procedure above does not dislodge the dust particles, use a board to depress one octave of notes (7 white and 5 black keys) and then adjust the bus bar shifters while holding the keys down.*

* - this procedure has been deemed inappropriate in recent years and could cause damage to the key contacts - JL

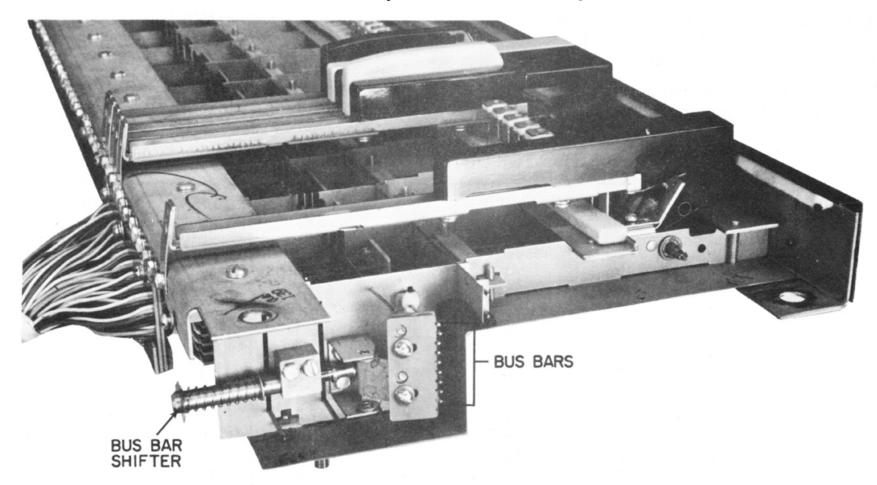


Figure 4–2. Manual Assembly, End View

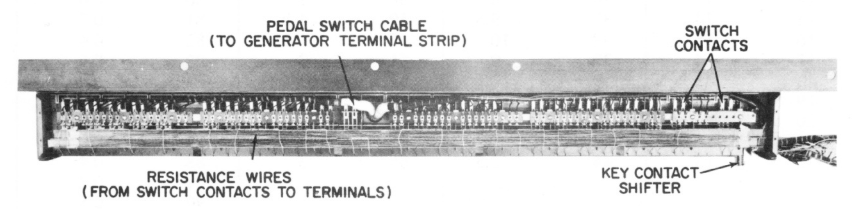


Figure 4–3. Pedal Switch Assembly, Cover Removed

STAGE DATA AND FINAL TESTING

5-1. DETAILED THEORY OF OPERATION.
5-2. MAIN TONE GENERATOR ASSEMBLY.

5-3. The main tone generator assembly consists principally of 48 rotating sub-assemblies (each subassembly consists of a shaft, 2 disks called tone wheels, and a bakelite gear), and a drive shaft which extends the entire length of the generator. This drive shaft is resiliently coupled at one end to a starting motor and at the other end to a synchronous run motor (reference paragraph 5-12), and is divided into several sections connected by semi-flexible couplings. A series of 24 driving gears, 2 each of 12 sizes, is mounted on this shaft.

5-4. Twenty-four of the 48 rotating subassemblies are mounted on each side of the drive shaft so that each of the driving gears engages 2 bakelite gears associated with opposite rotating subassemblies. These bakelite gears rotate freely with the tone wheels on separate shafts and are connected to their respective assemblies by a pair of compression-type springs. The bakelite gears are provided in 12 different sizes corresponding to the 12 driving gears of different sizes. Consequently, 4 of the tone wheel subassemblies, each containing 2 tone wheels, operate at each of 12 different speeds. Each driving gear, with its associated bakelite gears and 4 tone wheels, is contained in a separate compartment, magnetically shielded from the rest by steel plates which divide the generator into a series of bins. (See figure 5-2 on next page). All four tone wheels in anyone compartment run at the same speed.

5-5. Each tone wheel is a steel disk about 2 inches in diameter and contains a predetermined number of high and low points on its outer edge. (See figures 2 & 3 in Main Generator section.) Each high point is called a tooth. There are 12 wheels with 2 teeth, 1 wheel to operate at each of the 12 speeds (reference paragraph 5-4); similarly 12 wheels each have 4 teeth, 8 teeth, 16 teeth, 32 teeth, 64 teeth, and 128 teeth; also 7 tone wheels have 192 teeth. A 2-tooth wheel and a 32-tooth wheel form an assembly, giving 2 frequencies, 4 octaves apart. The 4- and 64-tooth wheels are assembled together, as are the 8- and 128- tooth wheels and the 16- and 192-tooth wheels. Five 16-tooth wheels are mounted with blanks to maintain the balance of the rotating unit. (See figure 5-2 on next page.) Only 91 frequencies are required for the organ; for identification purposes these frequencies are numbered 1 to 91 inclusive.

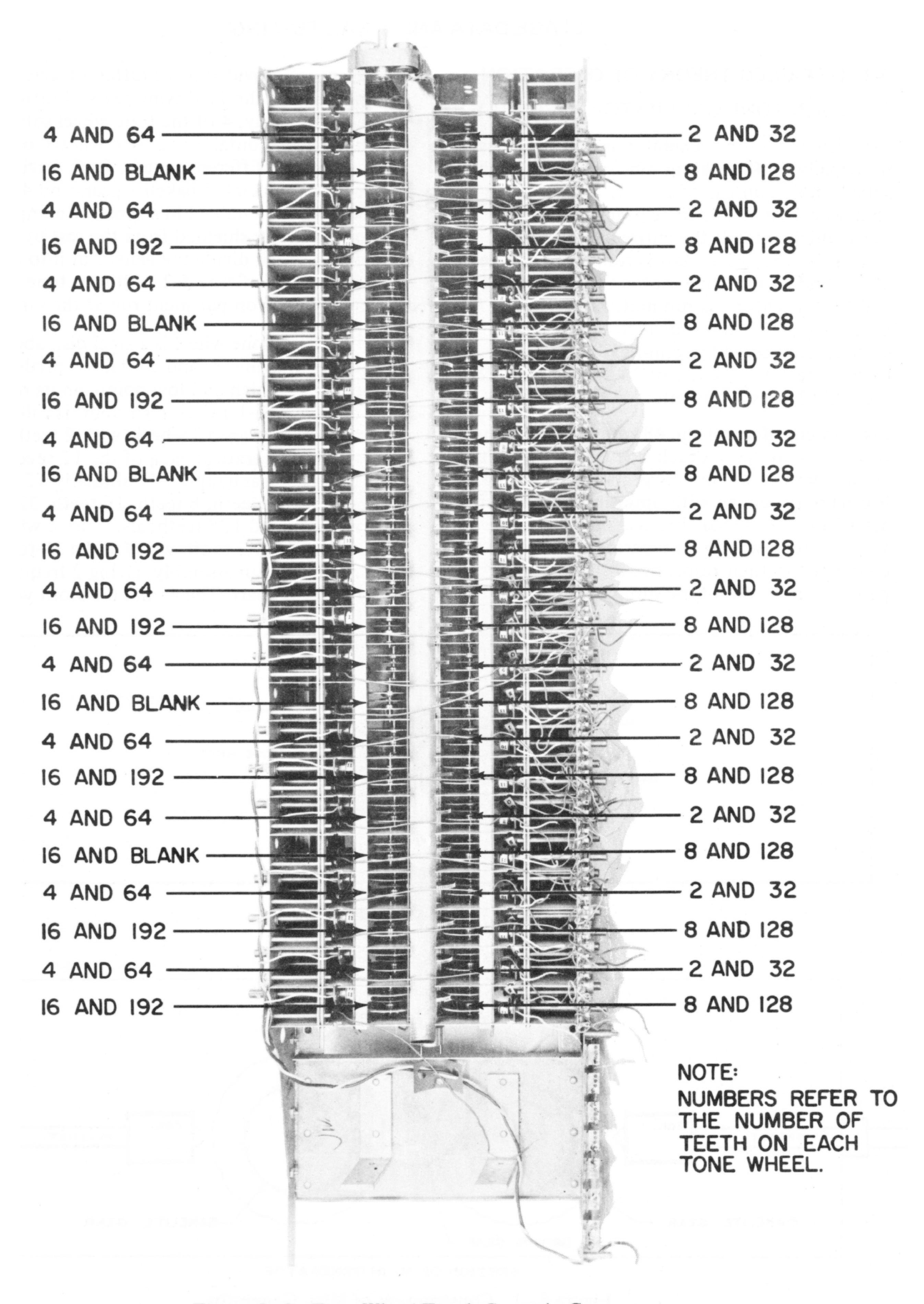


Figure 5–2. Tone Wheel Tooth Count in Generator

5-6. A magnetized rod, about 4 inches long and 1/4 inch in diameter, is mounted near each tone wheel. (See figures 5-1 and 5-2.) A small coil of wire is wound near one end of the magnet. The tip of the magnet at the coil end is ground to a sharp edge and mounted near the edge of the associated tone wheel. Each time that a tooth of the wheel passes the rod, the magnetic circuit changes and a cycle of voltage is induced in the coil. The voltage is very small and is of known frequency. The frequency is predetermined by the number of teeth and the speed of the rotating tone wheel. Larger coils are used with tone wheels of lower frequencies to provide good low frequency output, but smaller coils are used with tone wheels of higher frequency to prevent excessive losses.

5-7. Copper rings are mounted on certain low frequency coils for the purpose of reducing harmonics. The eddy current loss in such a ring is small for the fundamental frequency of the coil, but is high for its harmonics. As a result, the the relative intensities of any harmonics which may be produced by irregularities in the tone wheels are reduced.

5-8. The edge of each tone wheel and the tip of each magnet are coated with lacquer to prevent corrosion, for, should oxidation set in, the change in tooth shape would introduce undesirable frequencies.

5-9. Filters for eliminating spurious harmonics from the generated simple tones are located on the top of the main tone generator, and consist of filter capacitors and reactors. (See figures 5 & 6 in the Main Generator section.) (These capacitors and reactors are tuned units and are called tone generator filters.)

5-10. The tone generator filters have a single tapped winding. This tap is grounded and one side, which is connected to the associated coil assembly through a capacitor, forms a resonant circuit for the fundamental frequency of that coil. Harmonics are suppressed. The capacitors for frequencies 49 to 54 inclusive are 0.255 mf, and the capacitors for frequencies 55 to 91 inclusive are 0.105 mf. Both capacitors and reactors are used with frequencies numbered 49 to 91 inclusive. On frequencies 44 to 48 inclusive, the capacitors are omitted, but the reactors used have a greater number of turns. Below frequency 44, neither capacitors nor reactors are used; a length of resistance wire shunts each generator output. This resistance wire is wound on the appropriate magnet coil.

5-11. The tone generator filters are mounted on top of the generator at an angle to minimize reaction between them. Wires connect the filters to the coil assemblies and to the terminal strip on the generator. Ninety-six terminals are provided on this strip; 3 terminals are grounded to the generator frame and serve to ground the manuals and pedals, and 91 terminals carry the various frequencies.

5-12. The start motor is a shaded-pole induction motor. The synchronous run motor (used on 60 cycles) has a 2-pole field and 6-pole armature, and a synchronous speed of 1,200 rpm (revolutions per minute). For 50 cycles, a 4-pole armature is used which has a speed of 1,500 rpm. When the organ is placed into operation, the start switch is first operated to apply power to the start motor. The rotor of the start motor slides endwise and engages a pinion on its shaft which a gear on the generator drive shaft. (See figure 5-3 below.) When the RUN switch is operated, while the start switch is held in ON position, power is applied to the synchronous run motor and a 250-Ohm resistor (1,000 ohm for 234 volts) is connected in series with the start motor, thus reducing the driving power of the start motor. Because of the braking action and the loss of power of the start motor, the system slows down to, and locks into, synchronous speed; the run motor then begins to carry the load. When the START switch is released and springs back into position, the start motor disengages from the drive shaft by action of a spring assembly, and stops.

5-13. The spring couplings of the motor shaft, the flexible couplings between the sections of the drive shaft, and the tone wheel spring couplings are provided to absorb the variations in motor speed. The synchronous motor operates with a series of pulsations, one each half-cycle. If the tone wheels were coupled rigidly to the motor, this irregularity would carry extra frequencies into each tone wheel. The spring suspension system for supporting the main tone generator minimizes the transmission of mechanical vibration between the console cabinet and the main generator.

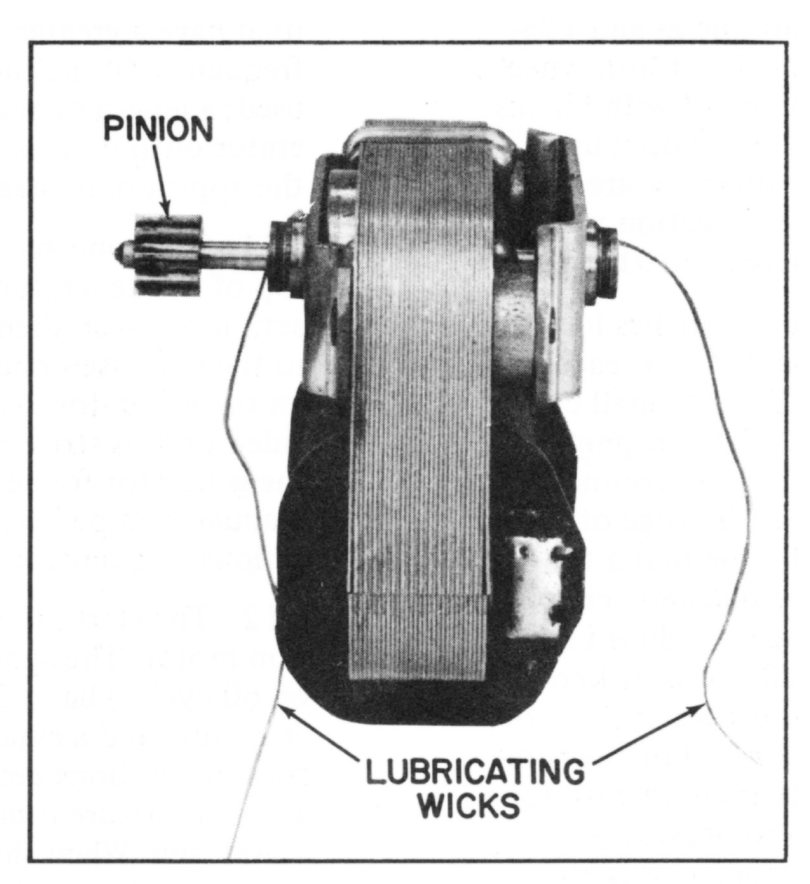


Figure 5–3. Starting Motor

5-14. VIBRATO EQUIPMENT.

5-15. The vibrato effect is created by a periodic raising and lowering of pitch, and thus is fundamentally different from a tremolo or loudness variation. It is comparable to the effect produced when a violinist moves his finger back and forth on a string while playing, varying the frequency while maintaining constant volume.

5-16. The Hammond Organ vibrato equipment, as shown in simplified block diagram, figure 1 in the Vibrato and Percussion section, varies the frequency of all tones by continuously shifting their phase. It includes a phase shift network or electrical time delay line, composed of a number of low pass filter sections, and a capacity type pickup or scanner, which is motor driven so that it scans back and forth along the line.

5-17. Electrical waves fed into the line are shifted in phase by each line section (the amount per section being proportional to frequency), so that at any tap on the line, the phase is retarded relative to the previous tap.

5-18. The scanning pick-up traveling along the line will thus encounter waves increasingly retarded in phase at each successive tap, and the signal it picks up will continuously change in phase. The rate at which this phase shift occurs will depend on how many line sections are scanned each second.

5-19. Since a cycle is equivalent to 360 electrical degrees, a frequency shift of 1 cycle occurs for each 360 electrical degrees scanned per second. For example, if the scanner passes over the line at such a rate that 3,600 electrical degrees are scanned each second, there will be a frequency change of 10 cycles.

5-20. For the widest vibrato, the whole line is scanned from beginning to end in about 1/14 second, and this rate of change of phase causes about 1-1/2 percent decrease in frequency. Note that the frequency remains constantly 1-1/2 percent low as long as the moving pick-up retards the phase at a constant rate.

5-21. Since the pick-up sweeps from start to end of the line and then back, it increases the frequency by an equal percentage on its return trip, the average output frequency remaining equal to the input frequency. The exact amount of frequency shift depends not only on the amount of phase shift in the line but also on the scanning rate. This rate, however, is constant because the scanner is driven by the synchronous running motor of the organ.

5-22. The degree of vibrato (or amount of frequency shift) may be varied by a switch which causes the whole line to be scanned for No.3 (wide) vibrato, about half of it for No.2, and about one-third for No.1.

5-23. A vibrato chorus effect, similar to the effect of 2 or 3 slightly out-of-tune frequencies mixed together, is obtained when the vibrato output signal is mixed with a portion of signal without vibrato. For vibrato chorus, part of the incoming signal appears across the vibrato line and the rest across a resistor in series with the line. As the vibrato effect is applied to the part of the signal appearing across the line, but not to the part appearing across the resistor, the combination produces a chorus effect. For normal vibrato, this resistor is short-circuited. In the Model C-3 console the vibrato effect can be applied to either manual separately or to both at once.

5-24. Figures 2, 3, & 3a in the Vibrato and Percussion section shows the vibrato line box. Each of the inductance coils is connected with one or more capacitors to form one filter section.

5-25. Figure 4 in the Vibrato and Percussion section shows the construction of the vibrato switch.

5-26. The scanner, shown in figure 5 of the Vibrato and Percussion section, is mounted on the main generator synchronous motor and driven at 412 revolutions per minute. It is a multi-pole variable capacitor with 16 sets of stationary plates and a rotor whose plates mesh with the stationary ones. In Index B of the same figure, two sets of plates have been removed to show the rotor.

5-27. Signals coming from the line through the vibrato switch appear on the stationary plates and are picked up, one at a time, by the rotor. Connection to the rotor is made by carbon brushes, as shown in figure 5, Index A of the Vibrato and Percussion section. Two brushes touch the sides of the contact pin and a third presses on the end, in order to eliminate the possibility of contact failure.

5-28. Figure 1 in the Vibrato and Percussion section shows the vibrato circuit.

5-29. The vibrato switch has no OFF position, and 3 vibrato chorus positions (C1, C2, and C3) are included in it as well as the 3 vibrato positions (V1, V2, and V3). The vibrato effect is turned ON and OFF for each manual separately by means of VIBRATO SWELL and VIBRATO GREAT tablets on the manual assembly.

5-30. The preamplifier used with this circuit has two separate channels into which signals from the VIBRATO GREAT and VIBRATO SWELL tablets are fed. (Reference paragraph 5-37.) The VIBRATO signal goes through a preliminary amplifier, through the vibrato system, and then into additional stages of amplification. The NO VIBRATO signal also has a preliminary amplifier, but bypasses the vibrato system and goes directly into the additional amplifier stages.

5-31. MANUAL CHASSIS ASSEMBLY.

5-32. The 9 contact springs on each key are connected by resistance wires to the proper terminals on the terminal strip and carry the harmonics of the particular note with which they are associated. The resistance wires avoid overloading of the generators and thus allow each generator to be used independently to feed a number of key circuits. All key contacts are alive at all times. When a playing key is depressed, its 9 frequencies are impressed on the 9 bus bars of the manual. No wires are connected to these bus bars; a preset or adjust key must be depressed to complete the circuit. (See console schematic) Each preset or adjust key is provided with 9 contacts identical to those on the playing keys and is further provided with a locking and tripping mechanism, the purpose of which is to permit only 1 preset or adjust key to be in operation at a time. The cancel key releases a depressed preset or adjust key; this cancel key has no contacts.

5-33. Flexible wires connect the 9 contacts of each adjust key (A# and B) to the 9 drawbars controlled by the key. The wires are color-coded for identification. Each drawbar makes contact (according to the stop position to which it is drawn) with any one of 9 busbars connected to taps on the mixing transformer. (See console schematic). The bus bars correspond to different intensities of sound.

5-34. The 9 preset keys (C# to A) are connected by flexible leads to the preset panel in the back of the console. (See Rear Views of consoles at end of General Descriptions section). The preset panel consists of 2 sets of 9 busbars which correspond to those in the drawbar assembly and which are connected to the same taps on the matching transformers.

5-35. The matching transformers are mounted on the manual chassis assembly as shown in Rear Views of consoles at end of the General Descriptions section. Shielded leads carry the signals from the secondaries of these transformers to the preamplifier.

5-36. PEDAL SWITCH ASSEMBLY. The pedal switch assembly is similar in operation to the manual chassis assembly (reference paragraphs 5-31 to 5-35 inclusive); the pedal switch assembly, however, contains only 4 bus bars instead of 9. A flat spring at the end of each pedal of the detachable pedal clavier depresses a small plunger, as shown in figure 5,(p.6) of the Manuals, Pedals, etc. section, on the pedal switch assembly and actuates a double set of contact springs, thus making eight contacts available for each note the pedal contact springs are connected by decoupling resistance wires to terminals. A cable connects these terminals through a wiring tube to the proper terminals on the main tone generator strip. The pedal switch bus bars are connected, by means of four colored wires, through a filter reactor and resistor network to the pedal drawbars. (See figure 5-9 on next page.) The reactor and resistors filter out undesirable higher harmonics and serve to balance the pedal tones.

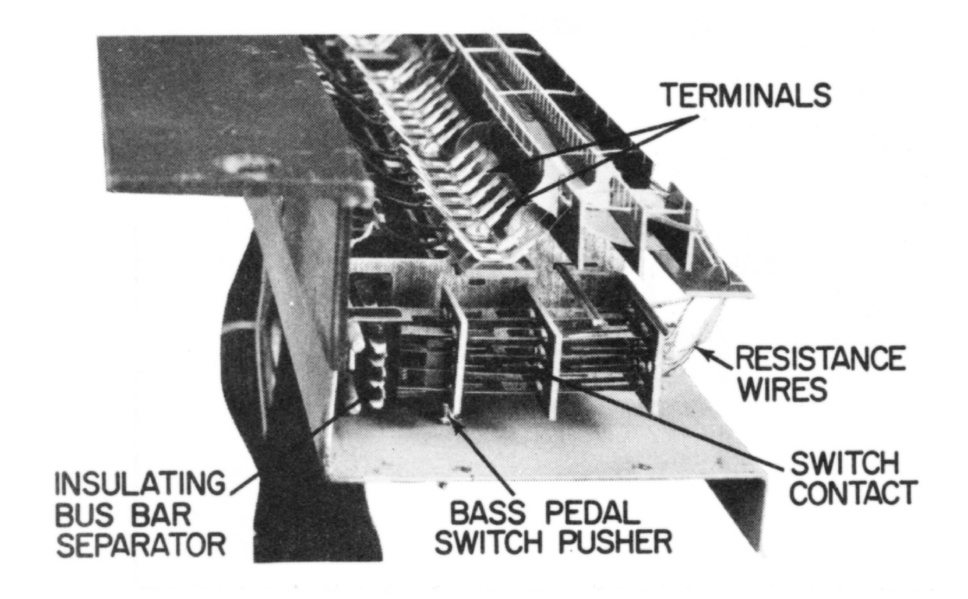


Figure 5–9. Pedal Switch Contacts

5-37. VOLUME CONTROL AND PREAMPLIFIER ASSEMBLY.
5-38. Typical Circuit Before Pre-amplifier.

5-39. Each voltage of predetermined frequency produced by the tone generator is connected to one or more key contacts. When the associated playing key is depressed, this voltage is impressed upon the bus bar and is carried through the preset key switch to the preset panel. The voltage is then fed to one of the several taps of the matching transformer which is associated with the manual being played. From the high impedance secondary of the matching transformer, this voltage (combined with others which may be fed through simultaneously) passes to one of the preamplifier input circuits. (Vibrato ON or OFF circuit).

5-40. Power to operate the preamplifier and power amplifier is supplied through the run switch circuit as shown in the console schematic.

5-41. Preamplifier Circuit, Input.

5-42. The signal from each mixing transformer is sent to the Vibrato ON-OFF tablet associated with its particular manual, and is then carried to the VIBRATO or NO VIBRATO preamplifier input, depending on the position of the tablet.

5-43. The input circuits are similar, with one extra stage of amplification in the VIBRATO channel to compensate for the loss that occurs through the phase shift network and associated scanner. The input tube V4 receives the signals from VIBRATO and NO VIBRATO circuits and further amplifies them. The signal then is impressed on the LOUD stator of the volume control, and on the SOFT stator through a compensating network.

5-44. Volume or Swell Control.

5-45. The volume control is activated by the swell pedal connected by an appropriate linkage. (See Rear View of consoles in General Descriptions section) The volume control assembly consists of two sets of stator plates, similar to those used in the scanner assembly. (See figure 5 in Vibrato and Percussion section.) A rotor assembly of similar size is moved by the swell pedal and is capable of meshing with either stator or a portion of each. The degree of mesh determines the strength of the entire signal.

5-46. The signal is further amplified by the second section of V4 and sent to driver tube V3 which in tum drives the 12BH7 output tube.

5-47. PERCUSSION SYSTEM. (See console schematic).

5-48. The Touch Response percussion feature is controlled by four tilting tablets (figure 8 in General Descriptions section). It is available only on the upper manual and only when the B adjust key is depressed. Percussion tones are produced by borrowing the second or third harmonic (depending on position of the Percussion Harmonic Selector tablet) from the corresponding drawbar of the upper manual B adjust key group, amplifying it, returning part of it to the same drawbar, and conducting the balance through push-pull control tubes which, when keyed, cause the signal to fade away at a pre-determined rate.

5-49. With the percussion tablet on, B adjust key pressed, and an upper manual playing key pressed, the second or third harmonic signal goes to percussion input terminal H on the preamplifier chassis and is amplified by T4 and T5.
The percussion input transformer T5 not only provides push-pull signal for the control tube V7 but also has a third winding which feeds signal back to the 2nd or 3rd harmonic drawbar through equivalent key circuit resistor R50
and terminal J.

5-50. When a key is depressed, the note first sounds loudly, after passing through the control tube V7, transformer T6, a high pass filter, and terminal D to the grid of V4. Immediately, capacitor C31 in the control tube grid circuit begins to discharge, causing the signal to fade away.

5-51. This circuit works as follows: Terminal K (Approximately -25 volts) is connected to the 8th harmonic B adjust key drawbar wire, which is connected through the adjust key contact to the manual busbar. Pressing any upper manual key connects this busbar to a tone generator terminal and virtually grounds terminal K through the tone generator filters. This virtually grounds the plate of V6, stops conduction, isolates the cathode of V6, and thus isolates the grid circuit of control tube V7. The grid then drifts from about -25 volts to about -15 volts, at a rate determined by the time required for C31 to discharge through R57 and R58. At the completion of this sequence, the percussion signal is blocked so that it is no longer audible.

5-52. No further percussion signal can be heard until all keys of the upper manual are released so that the control tube V7 grids can again drop to -25 volts (the rate of this drop is fixed by the time required to charge C31 to -15 volts through R55 and R56). Thus the percussion effect is heard only when keys are played in a detached manner; that is, when all keys are released before pressing the next one.

5-53. REVERBERATION UNIT. (See figure 3 in the Reverberation section) This device simulates musically desirable echoes in a large room. An electrical signal from the amplifier is applied to the driver coil in the reverberation unit, which converts the electrical signal into a twisting movement of 3 coil springs. This motion is transmitted along each spring to a pickup unit, where part of it is converted back to electrical energy. The remaining portion is reflected back to the driver and again back to the pickup after a time interval determined by the spring length. This reflection process continues until the signal level is reduced to about one millionth of its signal value so that it is no longer audible. The springs are different in length and thus there are 3 separate sets of echoes, each repeated a number of times. Electronic amplification circuitry associated with the reverberation unit is contained in the power amplifier, described below.

5-54. POWER AMPLIFIER. (See figure 26 in Tone Cabinet Amp section of Wiring and Schematic Diagrams)

5-55. This is a 3-channel amplifier with 2 treble channels (one for non-reverberated and one for reverberated signal) and a bass channel, with a cross-over point of 200 cycles. Each channel has two 6BQ5 output tubes with self bias. Each treble channel drives a 12″ speaker, and the bass channel drives two 15″ speakers in parallel.

5-56. The power supply unit is a separate chassis housing the power transformer, rectifier tubes, filter, and input connections for power and signal. A 6-pin plug engages the console cable, and a 5-pin receptacle is provided for plugging in additional tone cabinets. The console cable consists of 5 conductors; 2 for AC power, 2 for push-pull signal, and ground.

5-57. The push-pull signal from the console (G1 and G2) drives treble input tube V1. Resistance capacitance filters ahead of V1 filter out signal frequencies below 200 cycles. V1 drives output tubes V2 and V3 of the treble direct channel. It also drives double triode tube V9 which, in turn, drives the reverberation unit.

5-58. The output of the reverberation unit passes through transistor TR-1, and part of the signal goes to the treble reverberation switch. This adjusts the amount of reverberated signal going into V10, which drives output tubes V11 and V12 of the treble reverberation channel. The switch, in its off position, picks up signal from input terminal G1, in order to make use of the channel for non-reverberated signal when the treble reverberation is off.

5-59. Both treble channel output transformers have tertiary windings which supply inverse feedback signal to the cathodes of the output tubes.

5-60. A portion of the output of transistor TR-1 goes to double triode tube V4, which is connected as a phase splitter to drive the push-pull bass channel. The output of V4 goes to the bass reverberation switch, which is also connected to the input terminals G1 and G2. The bass channel receives a large amount of reverberated signal along with some direct signal in the HI position, only non-reverberated signal in the OFF position, and varying mixtures in the intermediate positions.

5-61. A filter network following the bass reverberation switch filters out signal frequencies above 200 cycles. Following it is a room size switch which can be used to provide better balance by reducing the bass volume when used in a small room. The signal then feeds push-pull tubes V5 and V6, which drive the bass output tubes V7 and V8.

5-62. REPLACEMENT OF COMPONENTS
5-63. TONE GENERATOR ASSEMBLY

5-64. Remove the four hexagonal-head bolts and their associated springs and T-washers which secure the generator assembly to the console.

5-65. Remove the four screws from the left and right hand side panels of the music rack. Tilt the bottom of the music rack by lifting the side panels, and remove the rack by pulling outward.

5-66. Remove the 4 chassis bolts (underneath the console) and the 2 machine screws (under the front lower manual rail) that hold the entire manual chassis in place.

5-67. Disconnect the 79 manual leads, 68 pedal leads, 4 ground wires, and the pedal filter leads. The pedal filter is located on the rear surface of the upper manual assembly.

5-68. Pull out all drawbars to position 8, and then tilt the manual chassis from the front as far as the top of the console will permit. Place suitable wedges or blocks on both sides of the manual chassis to hold it in this position. The manual chassis must be tilted to provide adequate clearance for the bolts in the comers of the main generator assembly.

5-69. Unhook the four suspension springs on which the generator assembly rides.

5-70. Lift up the generator assembly and remove it at the rear of the console.

5-71. Install a replacement generator assembly by reversing the procedure given above for removing it.

5-72. MIXING TRANSFORMER ASSEMBLY. The Assembly of two mixing transformers is provided complete with all leads to the preset panels, and can be removed as follows:

a. Remove the rear panel.
b. Remove the two screws which secure the transformer cover in place.
c. Label and disconnect all leads from the mixing transformers where they connect to the preset panels.
d. Unsolder green and yellow shielded wires at mixing transformers.
e. Remove the two wood screws which secure the mixing transformer assembly to the manual chassis block.

f. Secure the replacement mixing transformer assembly in place by reversing the procedures given above.

5-73. PLAYING KEY.

5-74. Replacement of playing key on upper manual will be accomplished as follows:

a. Remove the four screws from the left and right-hand side panels of music rack. Tilt the bottom of the rack by lifting the side panels and then remove the rack by pulling outward.

b. Remove the 2 wood screws and the 2 overhead bolts from the ends of the drawbar base.

c. Lift and block up the entire drawbar base.

d. To remove a black key, loosen its key mounting screw, unhook key from screw, and lift out key.

e. To remove a white key, loosen its key mounting screw and those of adjacent black keys. Unhook these keys from screws, push them back, and lift out white key.

f. Insert a replacement key and install by reversing the directions given above for removal.

g. Adjust the tension of the replacement playing key by comparison with the adjoining key.

5-75. Replacement of playing key on lower manual will be accomplished as follows:

a. Remove the four screws from the left and right hand side panels of the music rack. Tilt the bottom of the rack by lifting the side panels and then remove the rack by pulling outward.

b. Remove the two oval-head bolts from the ends of the stop base.

c. Pull out all drawbars to position 8.

d. Tilt the upper manual as far back as the top of the console will allow, and then wedge or block it in this position.

e. Complete the replacement of the playing key on the lower manual by following the same procedure given above for upper manual keys.

5-76. PEDAL SWITCH ASSEMBLY.

5-77. Replacement of pedal switch assembly will be accomplished as follows:

a. Remove the pedal clavier by lifting it up in front and then pulling straight back.

CAUTION:
Be careful to prevent damage to the delicately constructed pusher levers (switch pushers) at the end of each pedal.

b. Unsolder the pedal cable wires from terminals on the generator.

c. Disconnect the brown and black leads from the filter located on the rear surface of the upper manual assembly.

d. Disconnect the orange, red, and yellow pedal signal leads from the resistor strip on the rear surface of the upper manual assembly.

e. Use small wooden blocks to raise and support the entire console a few inches off the floor to provide the necessary clearance for the removal of the pedal switch assembly.

f. Loosen and remove the screws which hold the wiring tube (through which the pedal wiring cable passes to the tone generator) to the console shelf, the 3 oval-head and 1 hexagonal head screws which hold the pedal switch in place, and the screw which holds the swell pedal rod in place.

g. Lift the cover board and remove the screws which hold the pedal switch assembly to the back rail of the console.

h. Loosen the large bolt at each end of the pedal switch assembly then remove the nuts attached to these bolts. Drop the assembly carefully and remove it.

i. Install a replacement pedal switch assembly in place by reversing the procedures above.

5-78. MANUAL CHASSIS.

5-79. Replacement of manual chassis will be accomplished as follows:

a. Remove the rear panel of the console.

b. Remove the four screws on the left and right hand side panels of the music rack.

c. Lift the side panels to tilt the bottom of the rack. and then remove the rack by pulling outward.

d. Remove the 4 chassis bolts (under the console) and the 2 machine screws (under the front lower rail) that secure the entire manual chassis in place.

e. Disconnect all preamplifier leads.

f. Loosen set screw in expression control lever arm and detach arm from preamplifier.

g. Remove preamplifier from shelf after taking out mounting screws.

h. Unsolder (do not cut) the 79 manual leads, 2 ground leads, 3 pedal signal leads (red, orange, and yellow). and the pedal filter leads (brown and black).

i. At the power terminal panel, unsolder the five wires leading to the manual chassis start and run-motor switches. Determine these leads by tracing the leads from the switches.

j. Detach pilot lamp bracket by removing two wood screws.

k. Unsolder eight scanner wires from terminals on back of drawbar base.

1. Unsolder brown wire from vibrato line.

m. Tie the disconnected cables to the chassis to prevent damage to the other console components when the manual chassis is removed.

n. Remove the manual chassis through the rear of the console. Slide the chassis out carefully. Because of frame construction. the chassis will drop suddenly before it is entirely out of the console. Two men are required to remove the manual chassis from the console.

o. Install a replacement chassis by reversing the procedure above. (See figure 10 in the Cables and Connections section).

5-80. SWITCHES FOR START AND RUN MOTORS.

5-81. The switches for the start and run motors are both mounted on the same metal plate; the following replacement instructions are equally applicable to each:

a. Remove the black bakelite switch handle by unscrewing it in a counter clockwise direction.

b. Remove the round knurled nut which holds the switch to the metal plate.

c. Remove the four oval-head screws which hold the switch plate to the music rack.

d. Remove the rear panel of the console.

e. Unsolder the leads (from the defective switch) at the power terminal panel on the generator. One lead (black) is wired to the start switch. Four leads, 1 yellow,1 black, 1 blue, and 1 brown, are wired to the run switch. (See Console schematic). Unscrew or unsolder jumper wire between switches.

f. Remove the tape which secures the wires together. Unbraid the wires connected to the defective switch up to the manual chassis so that the switch can be removed.

g. Pull out the switch. Note the position of the switch with respect to the color of the wires so that the replacement switch will be installed in the correct position.

h. Install the new switch in the proper position. Braid and tape the wires carefully so that they will not interfere with the operation of the generator run motor.

i. Solder the leads of the replacement switch to the power terminal panel.

j. Operate the switch to determine that it has been installed properly.

k. Replace the rear panel.

5-82. START MOTOR (See figure 5-3 on p.17 of this section).

5-83. Replacement of the start motor will be accomplished as follows:

a. To make the start motor accessible, follow the procedure for removing the main tone generator. (Reference paragraph 5-63.)

b. Remove start motor capillary threads from oiling trough.

c. Disconnect the leads to the start motor at the power terminal panel on the generator.

d. Using a socket wrench, remove the two start motor mounting screws.

e. Secure a replacement start motor in position by reversing the procedures above.

5-84. RUN MOTOR AND VIBRATO SCANNER ASSEMBLY.

5-85. Replacement of run motor and vibrato scanner assembly will be accomplished as follows:

a. Remove the rear panel.

b. At the power terminal panel on the generator, unsolder the red and black wires which lead to the run motor that is to be replaced. (See console wiring diagram.)

c. Unsolder 7 scanner wires from terminals on back of stop base and 2 scanner wires from line box.

d. Remove shielded lead attached to SCAN at preamplifier.

e. The running motor is secured by four machine screws to the generator frame. Remove the nuts and lock washers, and then disengage the flywheel coupling springs.

f. Remove the entire motor and scanner assembly by means of a gentle pull.

g. Secure a replacement motor and vibrato scanner assembly in place by reversing the procedures above.

SCANNER REMOVAL, DISASSEMBLY AND REPAIR PROCEDURE

1. Detach motor and scanner assembly (A) from the generator assembly by removing four (4) nuts from the synchronous motor which anchors the motor to the "L" brackets of the generator assembly.

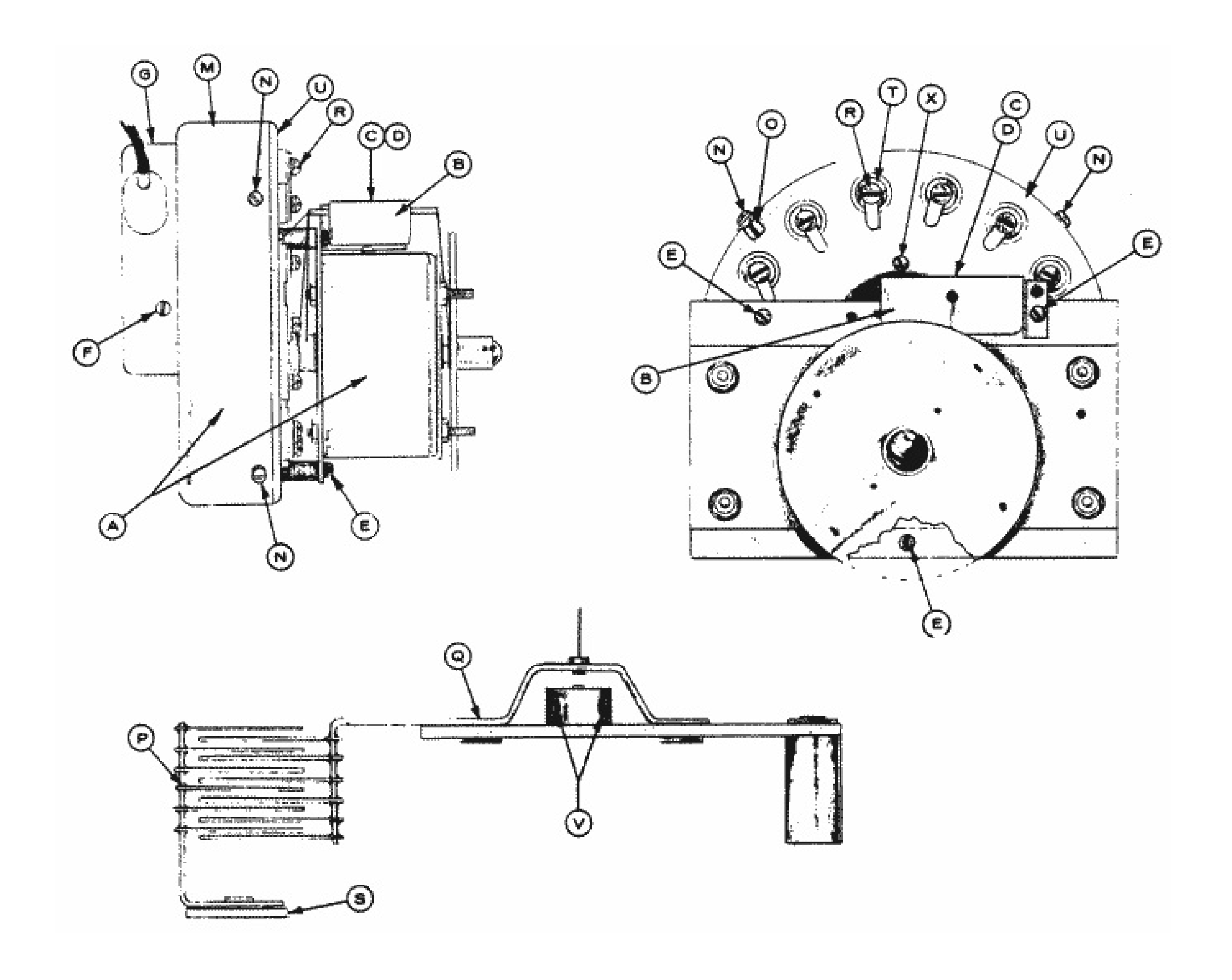
2. Remove the cable connections in the organ so motor and scanner assembly is free from organ.

3. Note A.C., line box, and output connections for reassembly.

4. Locate oil cup (B) and oil felt (C) inside cup. The oil felt must be removed and the cotton threads unwrapped from the felt before separating the scanner and motor. Remove felt retainer spring (D) and lift up on the felt to remove the threads. (Do this very carefully to avoid breaking the cotton threads). After removing the threads from the oil felt take a pick or a paper clip and remove the three threads from the one side of the oil cup by pulling them through the hole in the cup. The thread from the other side of the cup need not be removed.

5. Locate screws (E) which hold the motor and scanner assembly together. Remove the screws and pull the motor and scanner assembly apart. Note: There is a gear on the end of the motor shaft and must be guided through the hole of the scanner housing to separate the motor and scanner.

6. Remove two screws (F) from the rear cover (G) of the scanner. Before removing the cover note that there is a shielded wire attached to the cover. This wire is connected inside the scanner and there is very little slack in the wire. Remove the cover and tip it back carefully so you can see inside. Locate the carbon brush audio pick-up assembly (J). The carbon brushes must be removed before the main housing assembly cover (M) is removed, in order to prevent damage to the carbon brushes and tension springs. Lift end brush (I) and slip the two carbon brushes (H) off the rotor contact pin. (Be extremely careful of the rotor contact pin during disassembly so that you do not bend or break the pin).



Should it be necessary to remove the carbon brush audio pick-up assembly (J), desolder the audio wire from the brush assembly and remove the two (2) screws (K). To remove the end brush (I) remove screw (L) and separate from the brush assembly.

7. Remove the four (4) screws (N) and slip the housing cover (M) off the main assembly. Note: Mark the housing cover (M) and the main assembly chassis (U) to indicate the starting point of the scanner cable, also mark the location of the cable clip (O).

8. Stationary plates (P) and rotor (Q) are mounted on the main assembly chassis (U). Remove two (2) of the stationary plates (P), by removing screws (R). When removing the stationary plates from the assembly you will notice that there are insulator (S) and (T) on both sides of the main assembly chassis, insulating the stationary plates from the assembly (U). Then remove the rotor assembly (Q) by loosening the two (2) Bristol type set screws (V), to avoid damaging the rotor contact pin during disassembly.

9. Remove the remaining (14) stationary plates and insulators.

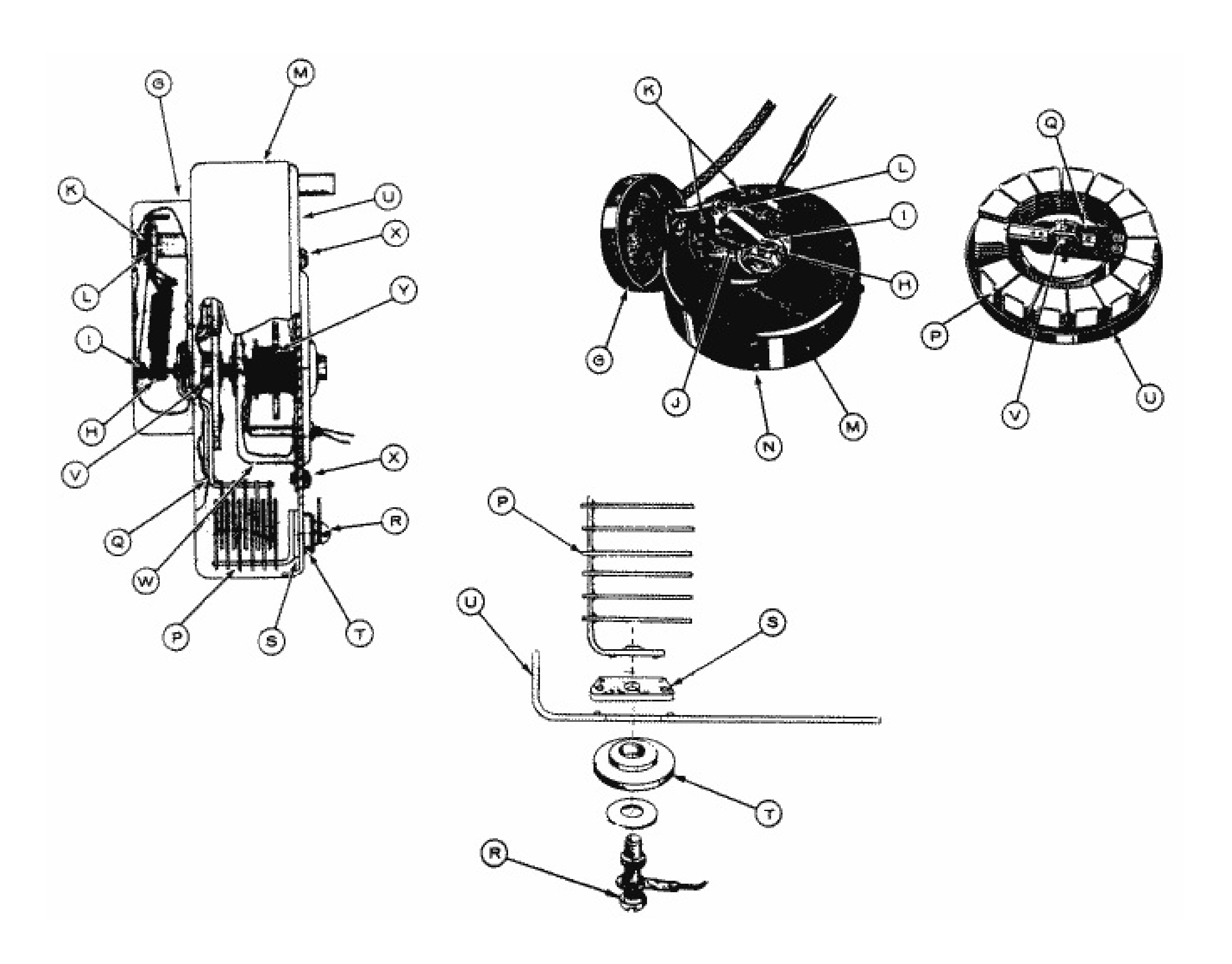
10. Clean the stationary plates, rotor plates and other metal parts using a reon spray or other cleaning solvents that do not leave any residue after drying. An absorbent cloth or swab can be used in conjunction with the cleaner.

11. Spray metal coated parts with a clear lacquer. Caution: Do not allow spray to get on oil threads or rotor pick-up pin.

12. In most scanner repair you need not go further in disassembly than step number eleven (11) but should conditions warrant further disassembly continue with number thirteen (13), otherwise install new insulators and reassemble the scanner.

13. In removing the gear housing assembly (W) there are four (4) screws (X) holding the assembly on to the main assembly chassis (U). Upon removing the gear housing assembly you will notice the Bakelite gear and shaft assembly (Y). The springs on either side of the Bakelite gear also intermeshes with the metal gear of the synchronous motor to drive the scanner.

14. To reassemble the scanner reverse this procedure.



5-86. TONE GENERATOR FILTERS.

5-87. Filters used for frequencies numbered 49 to 91 inclusive, as referenced in paragraphs 5-9 to 5-11 inclusive, are resonant reactor capacitor units, and will be replaced as follows:

a. Unsolder all leads.
b. Remove the two screws holding the filter.
c. Remove the component.
d. Replace the component by reversing the procedures above.